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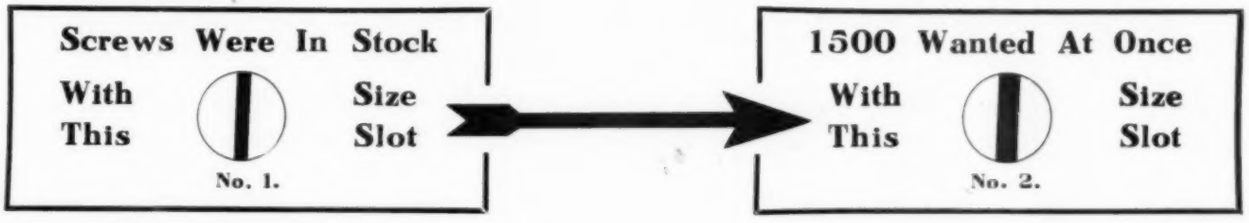
Index to Advertisers and Classified Index Following Reading Matter.

Record Results Achieved By Simonds Concave Screw Slotter Blade



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The Making of Modern Grinding Wheels

Giving an Outline of the Process by Which Carborundum Is Made and How It Passes from Crystals into the Completed Grinding Wheels

EDITORIAL CORRESPONDENCE

A machinist who was brought up with the grinding wheels in use before the days of the newer abrasives always thinks of all of them as emery wheels, whether he makes the mistake of saying it or not. But no matter what he calls them, he realizes that grinding wheels have improved greatly since the old days and he is more than interested in the manufacture, not only of the grinding wheels but of the abrasive itself.

Carborundum is an artificial product, due to the experiments of Edward Goodrich Acheson which began in 1891. The discovery was organized into a business when 10 carats of the stuff was ordered by workers of precious stones at the rate of about $860 a pound, because it could be used in place of diamond dust which sold for nearly double this amount. Naturally it did not find its way into general shop use at this figure, for grinding wheels for foundry use would be somewhat expensive, to put it mildly. When it was produced in quantities large enough to allow it to be sold for ten dollars a pound it began to be used sparingly in valve grinding, owing to its rapid cutting qualities.

The commercial manufacture of carborundum, as far as shop use is concerned, dates from 1895, when the plant was moved from Pittsburg to Niagara Falls, where it has grown and is still growing, both in variety of products and volume of output.

How It is Made

Carborundum is the product of coke, sand and heat; the first is very rich in carbon, the second is a sand high in silica and the heat comes from the huge electric power plant at Niagara Falls, giving an unmeasurable temperature to the mixture, but assumed to be about 7000 degrees Fahrenheit. The coke is pulverized and mixed with the sand in proper proportion, together with a little sawdust to aid in burning off the gases and preventing explosions and a pinch of salt to aid in the thorough mixing or fusing.

The mixed ingredients then go to the furnace, which is a sort of huge brick oven, perhaps 30 feet long and 7 feet across as seen in Fig. 1. The empty furnace, which looks more like a brick trough than anything else, is half filled with the mixture and then a core of granulated coke, perhaps a foot in diameter, is laid in the center from end to end and connected to current-carrying plates at each end. Then the core is covered with the mixture to make a cylindrical mass with the core in the center, the furnace bricked over the top, duly cemented in place and the current from old Niagara is turned on. The voltage starts at about 250 but is lowered as the resistance decreases until it comes down to an average of about 185 volts and continues for 36 hours, when the current is cut off and the furnace allowed to cool. The mixed sand and coke averaging 2 feet in thickness, is such a poor conductor of heat that the brick walls do not suffer in the least although they become enveloped in a blue flame of carbon-monoxide gas, of which 5½ tons are given off during the run of 36 hours.

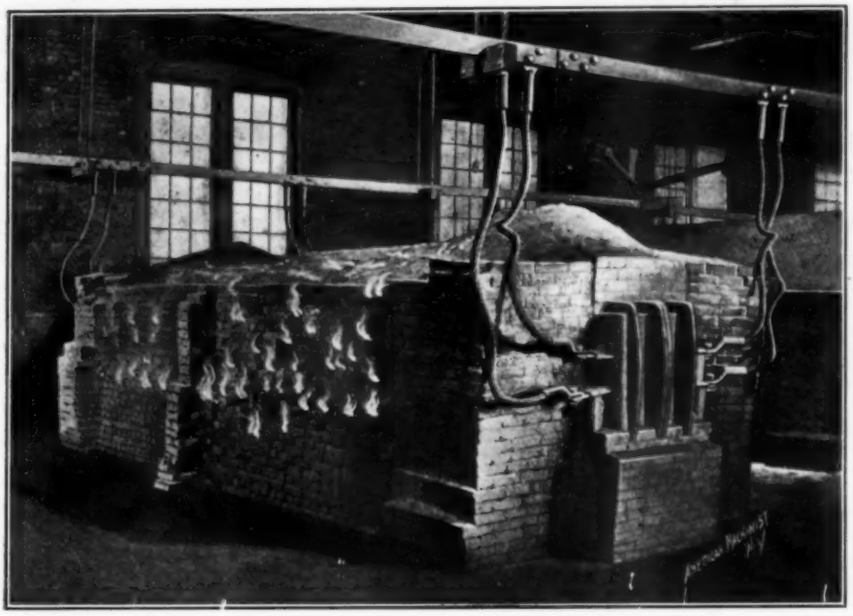


FIG. 1. THE ELECTRIC FURNACE

Two thousand horsepower is now consumed continually in each furnace which means a total of 72,000 horsepower-hours, or enough to carry an express train from New York to Salt Lake City. All the impurities are destroyed or driven off in gas and when the outer covering is torn away it reveals huge clusters of carborundum crystals, varying in size and color, but all making an excellent abrasive.

Crushing the Crystals

The crystals go to the crushers, as shown in Fig. 2, which consist of two manganese-steel wheels running in a large, heavy, circular pan of the same material. The crystals are dumped into the crushers, the pan revolved by heavy gearing not shown, and the rollers ride on the lumps to be crushed. As continuous dropping wears away a stone so the repeated action of the wheels on the carborundum at last reduces it to grains small enough for abrasive wheels, and incidentally it wears or cuts the hard manganese-steel wheels into all sorts of fantastic grooves and corrugations.

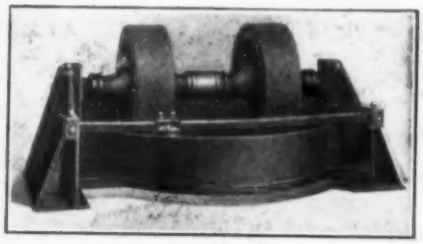


FIG. 2. THE CRUSHING ROLLS

From here it is conveyed to the cleansing bath of sulphuric acid which dissolves and removes the minute particles of steel that have been cut away from the crushing rolls. This has been found the most satisfactory as the magnetic removal plan was not always sure of getting it all out. It is then washed to remove the acid and is ready for the sifting or grading. Conveyers carry it up to the grading room and dump it into a hopper provided with an agitating spout which can give points to any massage artist. The screens too, shown in Fig. 3, have a quick, nervous

movement that carries the particles of carborundum along very slowly and allows them to fall through the screens when they find their proper size, into the barrels beneath. These screens grade the particles very closely and they are then ready to be made up into grinding wheels for various purposes, or one of the many shapes from the coarse rubbing brick to the fine razor hone.

Mixing and Molding

The mixing of the carborundum and the bond, which varies from kaolin or porcelain clay for the harder wheels to shellac for some of the softer grades, has to be done very carefully so as to get each particle of carborundum incased in an envelop of bond. This is done in mixers very like those used by candymakers in mixing chocolate, and consists of a bowl with revolving blades which mix the two materials thoroughly together, scraping it from the sides and doing a good job in every way.

The mixed bond and carborundum is then molded into the desired shapes much as in the making of cores in the foundry. Iron molds are used, and after being filled are placed under a hydraulic press and subjected to varying pressures up to 2000 pounds per square inch, according to the wheels or shapes being molded.

Puddled Wheels

Some wheels for special purposes are not subjected to heavy pressure, or in fact any pressure, but are mixed with water and molded up roughly or puddled, as shown in Fig. 5, and after drying enough to handle, are turned to size on a sort of potters' wheel or lathe with a vertical face plate.

In contrast with the molding of large wheels and special shapes is the making of the small wheels with which dentists of today put the inquisition of the dark ages in the shade. These are very small in some cases and are molded under the crank press, shown in Fig. 4, which is specially arranged for the work. Under the bench is a lever connected with the lower die of the press and which can be weighted so as to give any desired pressure. When that is reached the lower die moves down and raises the weighted lever, which can be compared very nicely to a safety valve of the old type.

As fast as these are molded they are laid in the terra cotta pans or trays on a bed of sand, as can be seen from the illustration, and are not disturbed until they have been through the kiln and are all baked and ready to use.

Thirty-minute Grinding Wheels

Right here may be as good a place as any to speak of a method of securing abrasive of the finest grit for special work, such as grinding jewelers' rolls. The carborundum is crushed as fine as possible and the particles floated in a stream of water through a long series of settling tanks. In each tank the majority of the grains settle to the bottom but the finer particles stay afloat and go over into the next. In this way very fine gradations can be made, some of the "grit" being afloat as long as 30 minutes and making what is known as "30-minute carborundum," to be used only in the very finest wheels, razor hones, etc., usually with kerosene oil as a lubricant.

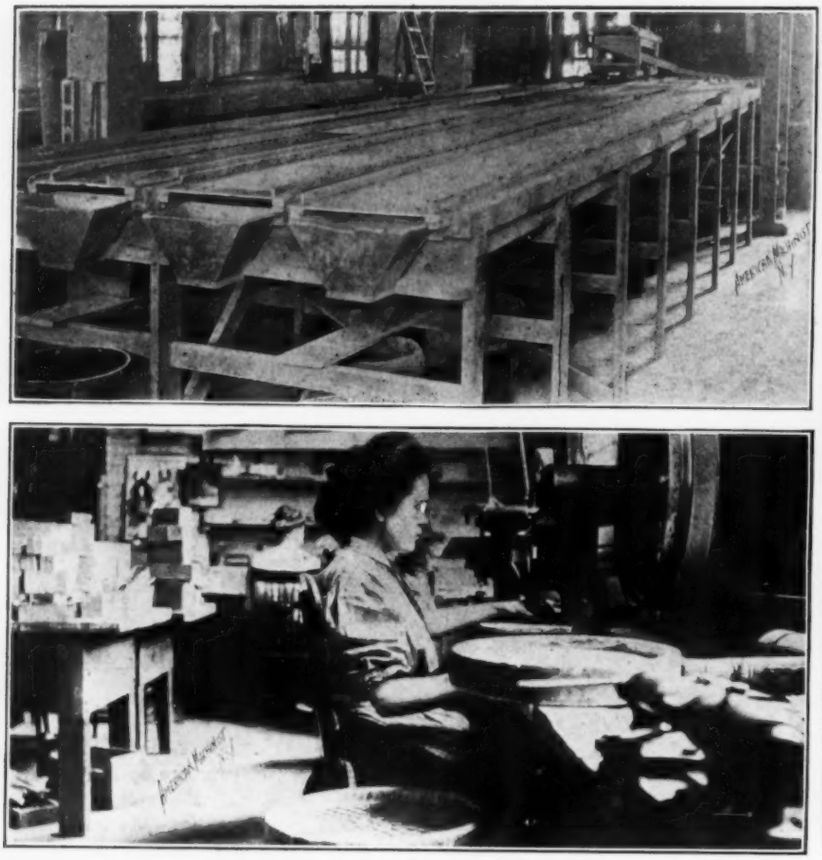


FIG. 3. GRADING MACHINES
FIG. 4. MOLDING DENTAL WHEELS

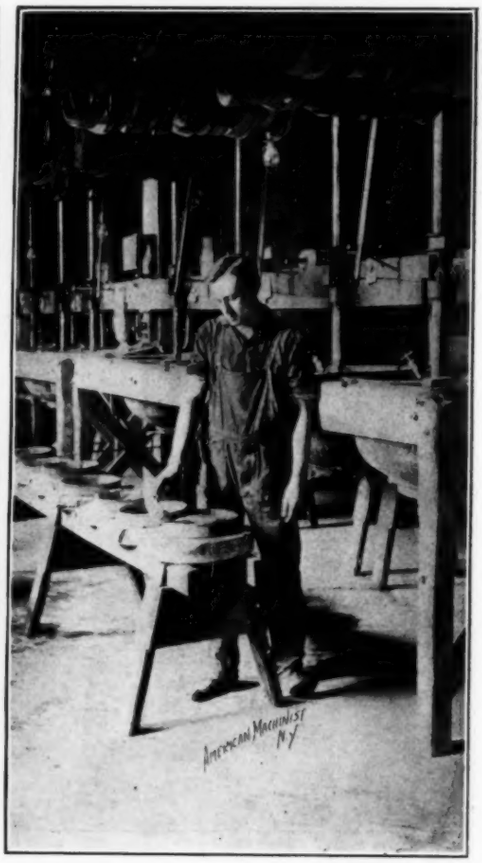


FIG. 5. PUDDLING WHEELS

Baking the Wheels

After the wheels and other shapes are molded, they go to the kilns for baking. These kilns are much the same as used in pottery work, being from 16 to 20 feet in diameter and probably three stories high in all. Beneath is the fire chamber with its doors for firing and removing ashes; above this the firing chamber or oven with a brick floor having openings for the heat to come through and outlets which compel it to make a complete circuit of the oven before it can get away.

Figs. 6, 7 and 8 give three views of the oven. The first is an interior which is really a remarkable picture, being a combination of flash and snap shot, showing the

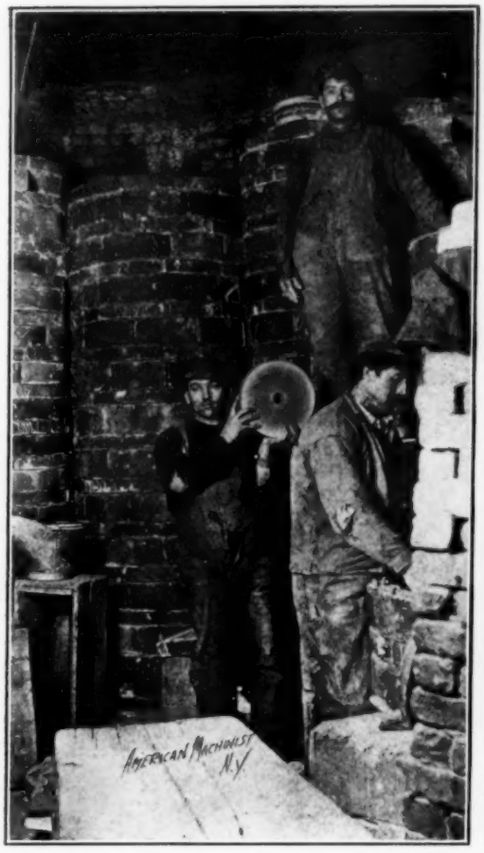


FIG. 6. FILLING UP THE KILN READY FOR BAKING

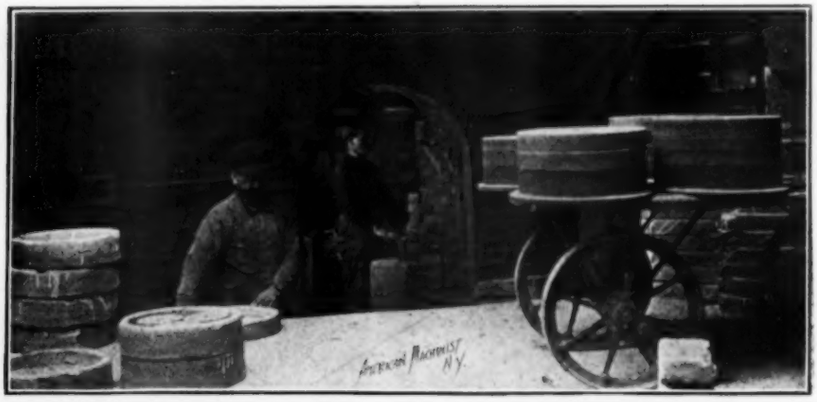
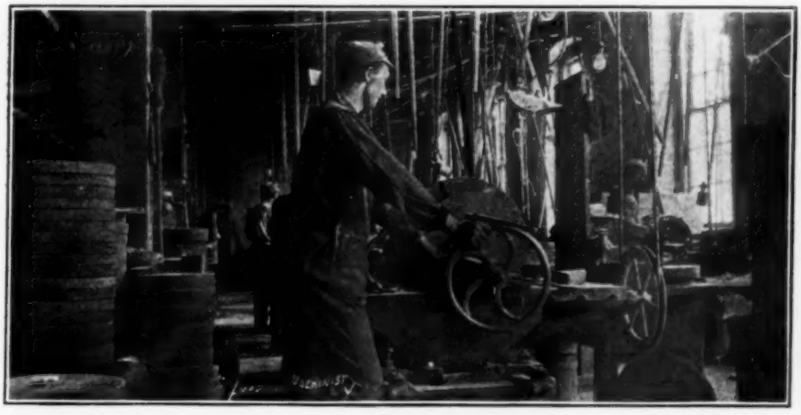


FIG. 7. VIEW INTO THE KILN FROM OUTSIDE

FIG. 8. KILN CLOSED UP READY FOR FIRING



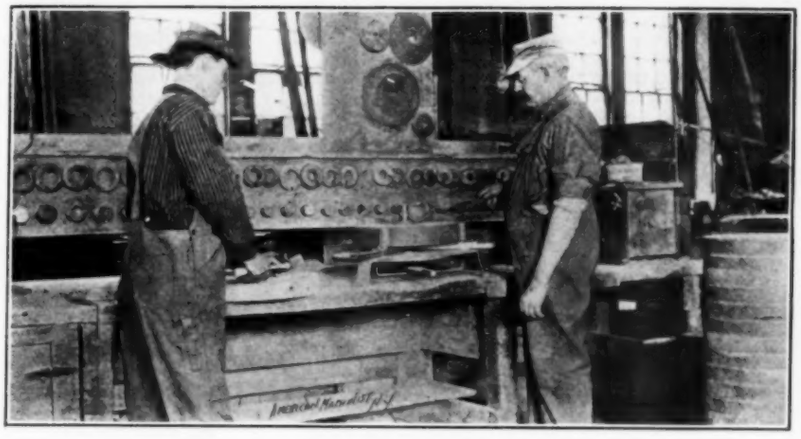


FIG. 9. TRUING SIDES OF WHEEL

FIG. 10. THE BUSHING BENCH

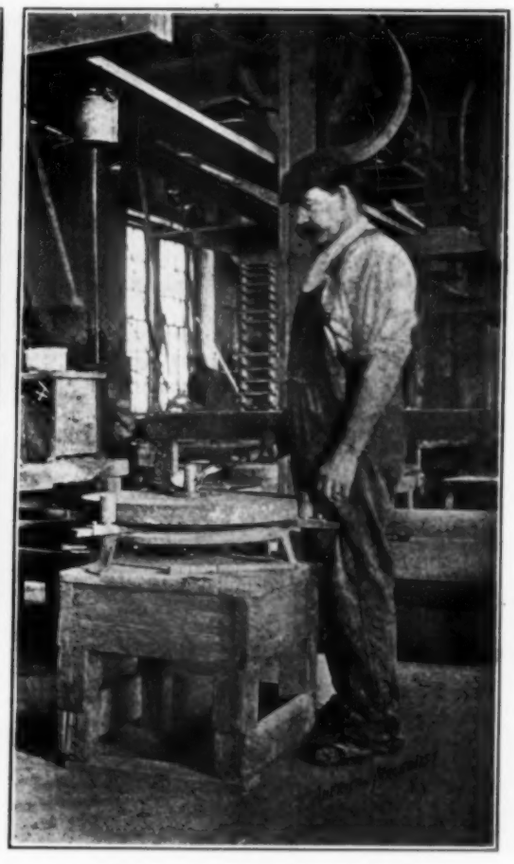


FIG. 11. BUSHING A LARGE WHEEL

method of packing in tiers and the tiles used. The wheels are laid on flat, round plates and surrounded by sections of curved tiles, as shown, to form a support for the next plate and to protect the wheels from the direct heat of the kiln. While these are not made absolutely tight a luting of clay is used between the supporting and the flat tiles. This luting clay is squirted out in ropes the same as fillet wax is made in the pattern shop, so as to be handy to use.

Small wheels are held in trays as was shown in Fig. 4 with the small dental wheels, and as can be seen in the case of much larger wheels, three in a pan, in Fig. 7.

It is quite a job to fill one of these kilns as they have a very capacious maw, as well as requiring care and practice to get in the most wheels and stack them so as to get an even heat.

The kiln once packed is closed up tight as shown in Fig. 8 and the fire started underneath, which must be kept burning continuously for three or four days and is then allowed to go out and the furnace to cool off.

Truing and Bushing the Wheels

Then the wheels are taken to the truing lathes as shown in Fig. 9, and gripped in the chucks shown while the sides are trued by the tool held in the carriage tool post. The tool is fed against the wheel by the large wheel shown while the rope drive at the back runs it across the face of the wheel and makes it true.

After the wheel is faced off, it must have its center bushing poured in place and be trued both on its sides and face. Fig. 11 shows a large wheel on the centering frame which consists of three arms, pivoted on a central disk which draws them in equally and centers the wheels by the three pins or rollers shown. Then an arbor of the right size is slipped in the center to form a core and the lead poured in place as shown.

Fig. 10 shows a complete pouring bench with a lead-melting furnace at the right, a centering chuck or plate in the center and arbors and washers on the board behind the bench. The man at the left is chipping off the bushing which sometimes needs a little attention.

With its bushing in place, the wheel is then taken to the face-truing stands, where it is slipped over the arbor and the face made true with the bore. In all this truing we find some type of wheel dresser used exclusively, either the star wheels or the corrugated disks being most in evidence.

Testing

The testing is all that remains to make them ready for the market and this is done in every case of wheels 8 inches or over in diameter. These are run in the testing machines shown in Fig. 12 to about double their normal speed, to make sure that no hidden crack exists to cause breakage and accident and injury to the user. The tachometer shows the speed accurately and the operator has it figured out for each diameter of wheel. The wheels are mounted in a sort of bomb-proof cage or box, built up of heavy planking so as to withstand any shock from a bursting wheel. Of course, this does not often happen but once in awhile a wheel lets go with a noise that would do credit to a fourth of July celebration.

FIG. 12. THE TESTING MACHINE

But it is much better to discover a defect here than afterward.

Other Wheels

Other wheels are made with a bond of shellac and are desirable for certain purposes. They are nearly always used with water as they cut much better wet than dry.

Another interesting wheel is known as the "flexible" and has a rubber bond. The crude rubber is used and after being properly "chewed" (no other term seems to adequately express it) by the rolls it is rolled into sheets and these sheets used as a base for imbedding the grains of carborundum. These are forced into the rubber as thickly as possible and after being cut into disks, the wheel is vulcanized instead of being baked and is then ready for use.

Tools for a Ball Thrust Cap

By Franz Valtier

The tool herewith described we designed for the manufacture of ball-thrust caps as used by the National Elevator Company.

Fig. 1 shows the finished cap, made of cast iron. Since our facilities are not faultless and in the absence of turret lathes, which would be the proper tool for this work we decided to use one of our 14-inch engine lathes.

First Operation

Fig. 2; here we used a regular 4-jaw lathe chuck to grip the casting for the first operation, which is that of boring the inside hole *A*, 5 inches in diameter, and in facing the back *B*. To bore this size accurately with one cut, we designed this special boring-bar holder fastened to the

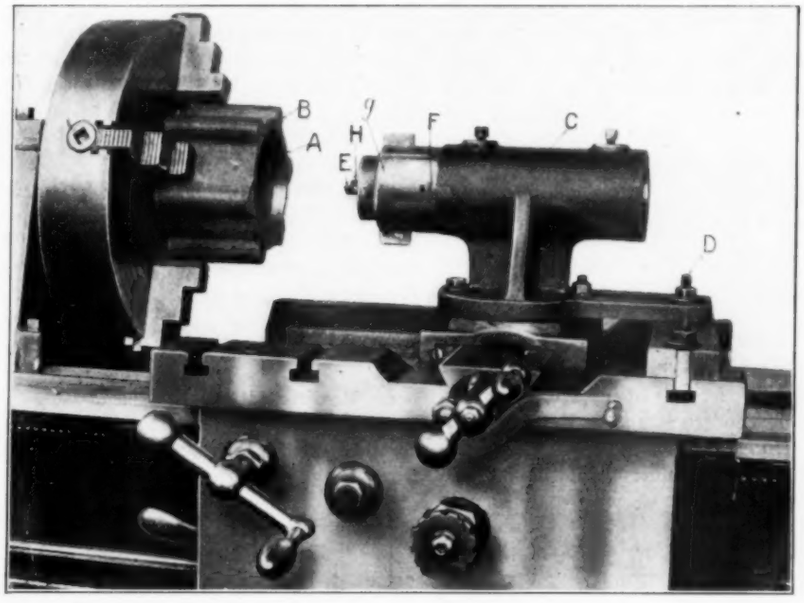


FIG. 2. TOOLS FOR THE FIRST OPERATION BORING AND FACING

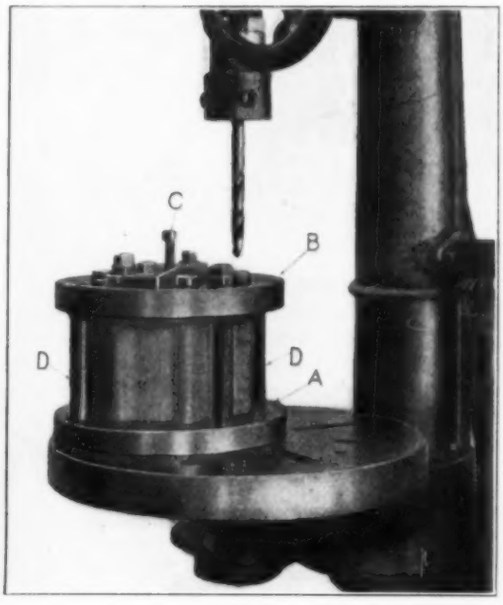


FIG. 3. TOOLS FOR THE SECOND OPERATION—DRILLING

cross slide. At the bottom we had a tail cast on, which could be clamped with bolt *D* to the lathe slide after the holder was located at its central position. In this way all strain was taken up and away from the slide gib, and made a positive lock at the same time. In the front of the boring bar we inserted a round roughing tool *E* to face the side *B*. The double end cutter for boring was made of high-speed steel and ground to size, fastened in the boring bar in the usual way with a set screw *H* in the front, which shows behind the facing cutter *E*. The boring bar itself is fastened with set screws and special key *F* to keep it from turning. Now the whole operation is as follows: chuck the casting, loosen the bolt *D* and face off the side *B* with the tool *E*. Feed the cross slide back against the stop (which cannot be seen), tighten the bolt *D* and feed boring bar in; time for whole operation 15 minutes.

Second Operation

Second operation (see Fig. 3) is drilling and shows the drilling jig. The bottom plate *A* holds four uprights to locate the jig plate *B*. This plate is fastened with two nuts, screwed on two uprights after the casting is in location and centralized by two more studs *D*, which are just long enough to reach through the plate *B*. The bottom plate *A* is arranged with a tongue to fit the bore of the casting. The set screw *C* is to hold the casting firmly during drilling. This jig is used as follows: Slip the casting in place to set on the plate *A*. Jig plate *B* is slipped over four posts and tightened by two nuts. Set screws *C* are screwed down. Time of operation including removing casting, 40 minutes.

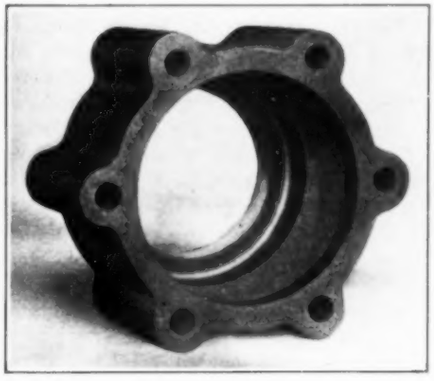


FIG. 1. A FINISHED BALL-THRUST CAP

Third Operation

The third operation is boring and facing the threaded plug hole. We used a special face plate arranged with tongue same as drilling jig, to locate the casting central and fasten with two bolts. We are using the same boring bar and holder as

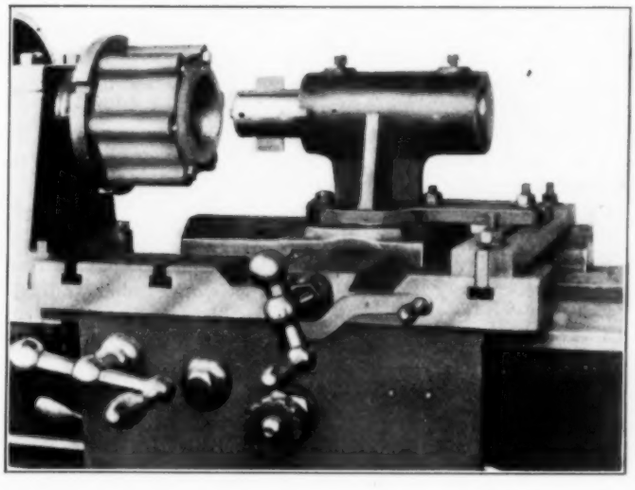


FIG. 4. TOOLS FOR THIRD OPERATION BORING AND FACING

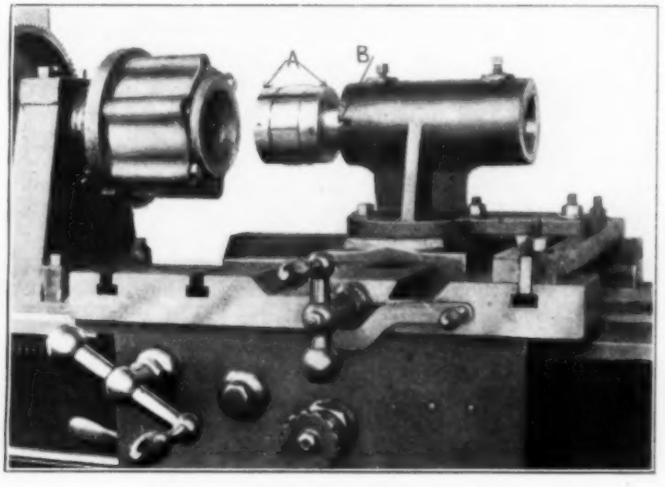


FIG. 5. TOOLS FOR THE FOURTH OPERATION—TAPPING

for first operation after the collar *G*, Fig. 2, is removed. This collar is for backing up and stiffening the cutter *G*, Fig. 2. In place of the key *F*, Fig. 2, we insert the facing cutter.

This operation is as follows: Fasten the casting to the face plate, feed in the boring bar, bore and face with one cut; operation time including removing casting, 12 minutes.

Fourth Operation

The fourth operation is tapping, Fig. 5. We use the same holder again with an adjustable tap. This tap of machine-steel body has four adjustable blades adjusted to size by the collars *A*. It is fastened to the holder by two set screws and the pin *B*. After the casting is located, the tap is started with the lead screw, geared corresponding to the thread, and the machine is reversed for back-feeding. The operation time including removing casting is 10 minutes.

It can be seen from this description that the whole operation time was 1 hour and 17 minutes. The boring bar made a straight, clear hole and did not show any vibration. We admit that any turret lathe will make better time than we did, but in the absence of this tool, these fixtures paid us very well.

Effective Organization in the Assembling Department

By Alfred Spangenberg*

Very little information is available on the subject of assembling. Writers on mechanical matters confine their attention chiefly to machine design and methods of machining work.

In machine work the proper shapes for cutting tools already have been determined by scientific experiment, also the proper feeds, speeds and depth of cuts for various materials. If we keep the machines plentifully supplied with work, furnish an abundance of high-speed cutting tools and see that the above conditions are being fulfilled, our problem of intensified production on machine work is easily solved.

Assembling work, on the other hand, is progressing only when the workman is busy. For this reason, if the cost of assembling is to be greatly reduced, it must be along the line of methods and processes for making the task easier for the workman. In connection with this, the system of pay is also a prime factor in stimulating production. The bonus system has always appealed to me as being the best wage system yet devised. It is easily understood, and is very effective.

There are many foremen in charge of assembling departments who want to do well and improve conditions, but lack the necessary training and experience which will enable them to secure the proper and best results from workmen, methods and processes.

With these points in mind, it is hoped this article may call forth some discussion among the readers of the American Machinist, on the possibilities that lie in the development of up-to-date methods of assembling.

Necessity for Careful Analysis

The waste of time in the ordinary assembling department of the average manufacturing concern is almost beyond belief. If any foreman feels the existence of unsatisfactory and unprofitable conditions, he must determine to analyze thoroughly the underlying reasons and remove the causes. Careful investigations coupled with a thorough campaign of action along organized lines will reveal the sources of lost time and enable the foreman to map out a logical and systematic plan for improvement.

If the foreman has such a knowledge of the work as he should have, and starts to make notes of these defects in methods, processes and organization he will be surprised at the number of his notations. Such a course compels the foreman to accumulate a very useful knowledge as to what must be done (and what must *not* be done) to accomplish the desired results. It may be well to state here, however, that before starting on any campaign for shop betterment it will be well to study carefully the character of the work, the ability of the men in the present organization and the systems already in use. Any innovations that are to succeed must be adaptable to these conditions. The intelligent support of the men will thus be secured. Any foreman who promises to "put in a system that will revolutionize the department and bring it up to efficiency," and who ignores this important point, is sure to fail.

Sources of Lost Time

The assembling-department foreman is placed in a rather unfortunate position in that he has to contend with conditions beyond his control. To the foreman who has well defined and carefully planned methods of assembling and has to wait for the machine work, or who receives last, pieces which are needed first, the job is appalling. Another condition with which we have to contend is that some of the machine work is not finished as accurately as it should be, and, therefore, takes a longer time to assemble. Manufacturing concerns who keep plenty of machined parts in store and have thoroughly organized systems of inspecting the parts before they leave the machine departments, will avoid considerable loss of time in the assembling department.

The defects and sources of lost time usually found in an assembling department may be classified somewhat as follows:

a. Time lost through lack of system in routing the work.

b. Lack of proper facilities for handling the work.

c. Loss through lack of high speed in drilling and insufficient number of straps and bolts for quickly clamping the work to the drilling machine.

d. Lack of proper drill jigs and fixtures for duplicating the work.

e. Wasted time due to haphazard methods and processes of assembling the parts.

f. Misdirected efforts due to lack of proper instruction to the men in regard to the best method of doing a job.

g. Lack of foresight in anticipating trouble; often necessitates taking work apart unnecessarily.

h. Inefficiency resulting from an improper division of the working force.

i. Failure to provide a system of pay that offers an extra reward to the men who attain standard time.

These sources of loss must be clearly recognized and logically grouped for study; if existing, they must be eradicated before any improvement can result. The possibilities that lie in the development of methods and processes of manufacture and systems of payment that directly affect the cost of assembling, are well nigh boundless. Some systems for accomplishing the very desirable results which can be secured are very elaborate and require a considerable amount of time and money to install. For this reason most managers are not willing to give the broader plans their unqualified approval.

I will attempt here only to lay down a few fundamental principles which can safely be followed and which are adaptable to many differing conditions. By the application of a few simple and natural methods I have been able to reduce the hours on assembling 40 per cent., and in a number of instances a saving of 60 per cent. was secured.

The Arrangement of an Assembling Room

The arrangement of an assembling room will vary with the character of the product. I am highly in favor of having the boring and drilling done in a separate department under a drill foreman, for the reason that these operations are distinctly machine work, the same as lathe or milling. With very few exceptions all boring and drilling can and should be completed before the work comes into the assembling department. Portable drills will take care of the drilling that has to be done by the assemblers.

Where it is the practice to do the boring and drilling in the assembling room, the machines for doing this work should be grouped where the work is received for convenience in routing. Suitable stands should be provided near the drills

*Foreman, turret lathe assembling department, Pond Works, Niles-Bement-Pond Company.

doing the smaller class of work for ease in handling the pieces and for the sake of saving room. Shelves for keeping all drill jigs and fixtures are needed and should be placed convenient to the boring and drilling machines. Spaces should be partitioned off on the shelves and numbered to correspond with the card index of the jigs. The form printed in Fig. 1 will give a good idea of the information

PIECE NO: P-2738. JIG NO. 1286. In Space No. 70.
MACHINE: 21" Rigid Turret Lathe.
USED FOR: Drilling Carriage Screw Bracket P-2738.
USED ON: Multiple Spindle Drill No. 3.
TOOLS USED: 4—17/64" Drills, 1—11/64" Drill, 1—3/8" Rosebit.
NO. OF LOOSE PIECES WITH JIG: 2 Bushings.

FIG. 1. FORM FOR JIG INDEX CARD

the cards should contain. The list of tools used with each jig is especially valuable where the drills and reamers are kept in the tool room. It will be advisable to have someone in charge of the jigs who is responsible (preferably the drill boss). If the men are allowed to help themselves, trouble will arise from misplaced jigs and lost bushings.

All castings should be cleaned thoroughly before they leave the foundry, and only such chipping and grinding done in the assembling room as is necessary to match the castings. A space with bench and vises for doing what cleaning and chipping is necessary to do in the assembling room will keep the muss and dirt in one place. This space should be near where the work is received, and can also be used by the painters.

In order to have some system for keeping track of the parts until wanted by the assemblers, a storeroom should be provided for placing the work in as it is received from the various sources. Bins should be provided in this storeroom for keeping the smaller pieces and stock supplies (screws, pins and keys) in groups. The size of these bins will depend on the character of the work handled. The bins will be numbered consecutively and an index provided giving the pattern and forging numbers of the parts in process and the number of the bin to which they belong. The convenience of this method of keeping the small parts will be explained later.

In addition to the usual wall benches with vises, a sufficient number of portable vise stands will be needed for the assemblers who are working on the floor. A sufficient number of boxes of a standard size will be useful for carrying the smaller pieces from the storeroom to the assemblers. These boxes should contain a partition in one end (for holding screws and pins) and also a tin pocket placed on the side for holding cards. The cards give the order number, name and group number of the pieces the box contains.

A standard place should be provided for keeping the portable drills, air hammers, box wrenches and other tools. Much time will be saved in looking these up if they are kept in the storeroom and given out on checks.

Speed lathes are often placed inaccessible to the workmen who use them, for the sake of belting the lathes to some line shaft. Motor drives will allow the lathes to be conveniently located. The necessity for ample crane facilities is too well recognized to need any comment here. The arrangement of the larger pieces and beds of machines in process of assembling, will vary with the character of the work. Aisles should be kept clear and beds placed so as to avoid crowding if possible.

Method of Assigning the Work

The task of apportioning the work among the men so as to secure a rigid subdivision of labor, requires careful thought. If this is done in a haphazard manner, poor results will follow. Modern practice tends toward a subdivision of labor that allows the high-priced mechanic to do no work that can be performed by cheaper men. If the workman can be confined to two or three operations the solution is not difficult. I have found the following plan to be successful in manufacturing work:

Classify all the parts which can be assembled in groups. This can best be accomplished by taking the assembly drawings of each machine separately and analyzing the various operations required to assemble the machine. It is highly advisable to make the classifications so that as small a number of pieces as possible constitute a group. This plan makes it easier to assign the work and confine each workman to a certain class of work.

A loose-leaf book will be a convenient form to use in following this method. The form printed in Fig. 2 illustrates the data required in making the classifications. A lead pencil should be used for checking in the columns marked, "Recd." and "Drill," so that by erasing, when the order is closed, the form can be used over again.

Index No. 11D.

ORDER NO. 40516.
MACHINE: 21" Turret Lathe.
PART: Feed Works.
Group No. 11. Carriage Feed Screw Bracket Members.

	P. or F.	Drawing.	W.	Recd.	Drill.	Stock.	W.
Screw bracket	P—2738	1506	24	24	X	1/2" Scr. 157	96
Feed reversing shaft	F—1721	1505	24	24	X		
Feed reversing shaft roller	F—1722	1505	24	24	O		
Feed reversing shaft plunger	F—1723	1505	24	24	O		
Feed reversing shaft spring	F—1724	1505	24	24	O		
Feed reversing shaft handle	P—2745	1506	24	24	X	7/32" Pin No. 2	24
Clutch collars	F—1725	1507	48	48	O	No. 15 Key	48
Clutch collar gears	P—2746	1507	48	48	O		
Clutch sleeve	F—1726	1507	24	24	O	No. 27 Key	24

X Denotes pieces are drilled.
O Denotes no drilling required.

FIG. 2. FORM FOR GROUPING PARTS.

Having completed the work of classifying, the groups should be logically arranged, numbered consecutively and indexed for ready reference. An alphabetical index is a good form to use. Assign one or more groups to each letter, according to the number of groups to be indexed. As the work is all received for any group, a check mark is made in this index, so that the foreman can tell at a glance just what work is ready to be assigned.

Another index, giving the pattern and forging numbers in sequence and the number of the group to which they belong, will be needed by the stock-room clerk for checking off and assigning the pieces to their proper bin. Two copies of the book are needed, one for the stock room and one for the foreman's office.

Method of Routing the Work

As the work is received from the various sources, the parts requiring boring or drilling are sent to the machines for doing this work. Parts not requiring these operations are placed in the storeroom. As the boring and drilling operations are completed the parts are painted and placed in store. This, of course, applies only to the smaller parts; the larger units and beds of machines should be placed on the assembling floor and their group number marked with white paint.

When the work on any group is to be assigned a helper is sent to the storeroom with a card bearing the name and number of the group, order number, drawing numbers, workman's name and number and standard time for assembling the parts. The card may take the form of a contract ticket, time card, or whatever form the system of pay requires. The helper receives the proper pieces and drawings and takes them in a box, together with the card, to the workman who is to assemble the group.

As soon as the units or groups are assembled they are sent to the store for finished parts or placed near the beds of the machines being erected, if the beds are in process. Careful inspection should be provided for as the work progresses. This system which is concrete, definite and simple, will enable the foreman to:

a. Make a rigid subdivision of labor.

b. Easily apportion the work among the workmen so that no delays need be encountered.

c. Have beside the workman only the job on which he is working and the next job on which he is to start.

d. Prevent the parts from becoming separated or lost.

e. Devote more time to supervising the workmen by saving the time usually required to look up the next job.

f. Keep an accurate check on the cost of assembling each group and determine the proper course to pursue in order to secure still greater economies.

Machinery Building in Japan*

BY A. GWAIKOKUJIN

One cannot but be surprised at the remarkable progress that is being made in manufacturing industries in Japan. Prior to the Japan-China war of 1894-95, Japan had been an importer of manufactured goods, but subsequently with the rise of manufacturing industries, machinery of various descriptions began to be imported in increasing quantities. Japan has now gone even farther and the manufacture of light machinery and machine tools has been started and is being briskly carried on.

By some it is claimed that Japan is now quite independent of foreign aid in the manufacture of arms and warships, as this work is being quite satisfactorily accomplished in the various naval and military arsenals of the government. It must, however, be admitted that as yet Japan has not been able to manufacture all the raw material which enters into the construction of her warships, as heretofore all plates and parts have come, for the most part, from Scotland and North of England. But the government foundries at Wakamatsu are now about ready to supply material for all ship-building purposes.

On a recent trip through the habutai silk district, it was found that machinery had been introduced for the production of habutai, and to such an extent that it is likely in a very short time they will do away with the hand method heretofore generally used throughout the country.

Steam and water power were being applied to weaving, sizing, drying, bleaching and producing the thread from the cocoon. The first of these machines were imported, and used as models, from which designs were made and from which the Japanese machines were produced; though the Japanese machines are of a much cheaper quality they are claimed to have an advantage over the imported ones, owing to their construction being cheaper and also they are better adapted to the Japanese workmen.

There is beginning to be an extensive demand in this country for electrical machinery, though at present there are only a few manufacturers of electric machines and supplies in Japan. Perhaps the most important of these are the Shibaura Engineering Company and the Tokio Electric Company, Ltd., which is a joint enterprise of the General Electric Company, of Schenectady, N. Y., and a body of Japanese.

The former company is owned by the well known Mitsui family, and has been in existence for some years, but was reorganized in August, 1904, with a 1,000,000 yen capital; the latter company has only been in existence for about three years, and has a paid-up capital of something over 700,000 yen. Owing to the limited capital for an industrial work of this kind the above companies have been confined to a very narrow field, though they are doing an extremely good business.

It is stated that these companies are concerned in the negotiation of amalgamation. The talk of amalgamation is alleged to have originated in the meeting between the president of the General Electric Company and Mr. Masuda, of the Mitsui company, when the latter visited America about two years ago. In the event of the companies coming to a successful understanding it will, without a doubt, be due to the recent visit to Japan of the general manager of the foreign department of the American company, who personally inspected the Shibaura Engineering Company and the Tokio Electric Company. It is understood that on the arrival of the foreign manager in America, for which place he recently left Japan, the question will be once more submitted to the board of directors when the contract is to be formally concluded.

According to the plan so far made public the new company will have a capital of 4,000,000 yen, 51 per cent. of which sum is to be held by the General Electric Company in exchange for the entire patent possessed by the company. The new company will not only supply Japan with all kinds of electric apparatus and machinery for which Japan has heretofore had to pay no small sums in freight and customs duty at a much cheaper price, but also will supply a large quantity to China, Korea and the Philippines.

The field for the commercial and industrial activity of Japan having been immensely enlarged as a result of the late war, there is little doubt that if she keeps going on with the progressive spirit now shown in the introduction and production of machinery that not only hand work in all its possible lines will ere long be supplanted by machinery and factory methods, but there should be a favorable opportunity for further American coöperation.

*For previous article see "Machinery Building in Japan," in AMERICAN MACHINIST, August 27, 1908.

A Twenty-foot Pit Lathe

As shown in Fig. 1, this is a lathe of more than ordinary dimensions. The main bearing is 30x24 inches, and the rear bearing 16x18 inches, and the spindle is 8 feet 2 inches long. Through the center of the spindle runs an 8-inch bar, used for boring the flywheels on the face plate. Placing an arm with a star feed on the end of the bar gives a facing tool for the limbs. The bar is turned inside the main spindle by the train of gears coming from the main drive shaft from the motor, and being controlled by the belt on the tight

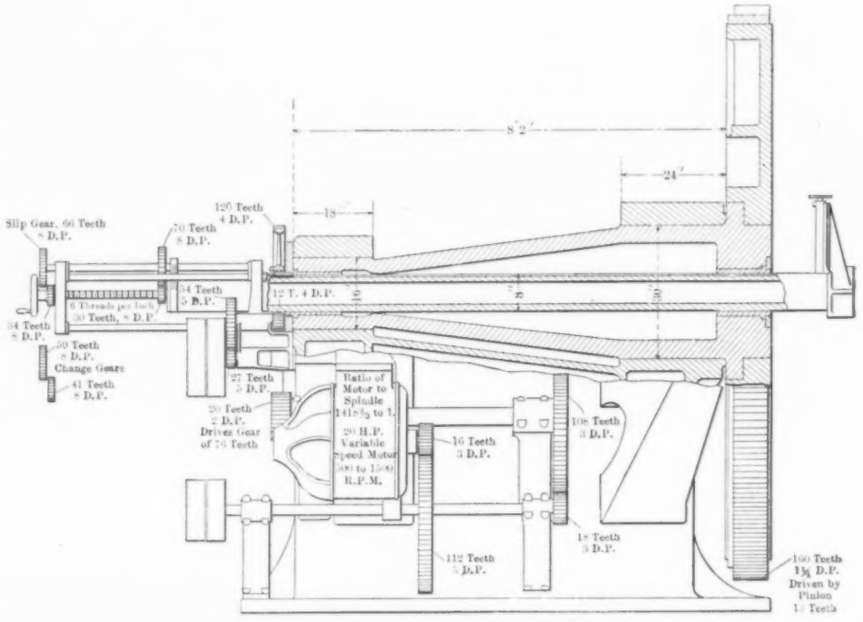

8' 2"
24"
18"
Slip Gear, 60 Teeth 8 D.P.
70 Teeth 8 D.P.
120 Teeth 4 D.P.
12 T. 4 D.P.
54 Teeth 5 D.P.
6 Threads per Inch 30 Teeth, 5 D.P.
54 Teeth 8 D.P.
50 Teeth 8 D.P. Change Gears
41 Teeth 8 D.P.
27 Teeth 5 D.P.
20 Teeth 2 D.P. Driven Gear of 78 Teeth
Ratio of Motor to Spindle 41⅝ to 1
20 H.P. Variable Speed Motor 500 to 1500 R.P.M.
16 Teeth 3 D.P.
108 Teeth 3 D.P.
18 Teeth 3 D.P.
112 Teeth 3 D.P.
100 Teeth 1½ D.P. Driven by Pinion 14 Teeth

FIG. 1. THE HEAD OF A 20-FOOT PIT LATHE

and loose pulley. The bar is also fed through the work from the same source and in addition, has the hand feed, as shown.

The variable-speed motor used gives the speed range, which need not be large owing to the holes being bored and the hubs faced independently of the speed of the lathe itself. The ratio between the motor and lathe spindle is over 1400 to 1.

The Carriage and Tools

The carriage is mounted on a separate casting or bed and is located for each job at approximately the proper distance from the center, for the wheel to be turned. The fine adjustment and feed into the cut are taken by the tool slide. The carriage support is at an angle, so as to cut radially with the center of the wheel and at the same time have the tools accessible without climbing upon a platform.

The sides of the rims are faced by a tool on each side, mounted in a tool post on the end of each of the round bars which run through the carriage body. These can be fed by hand or power from the cross-feed drive, the methods being shown in Fig. 2. The feed of the side-cutting tools is thrown in or out by the small lever shown at the left of the spiral gears. Both this and Fig. 3 show the star feed on the facing arm and feeding pin or knocker, put on the arms of the wheel itself as the boring and facing bar move independent of the main spindle.

Fig. 3 shows the side-facing tool posts for the rim, each tool being adjustable by a slide, as shown. It also shows the method of holding and driving the fly-wheel and the uptodateness of the design of wheel, with its double center arm.

This was designed by A. H. Steen, superintendent of the National Transit Company, Oil City, Penn., and has a capacity for wheels up to 20 feet in diameter.

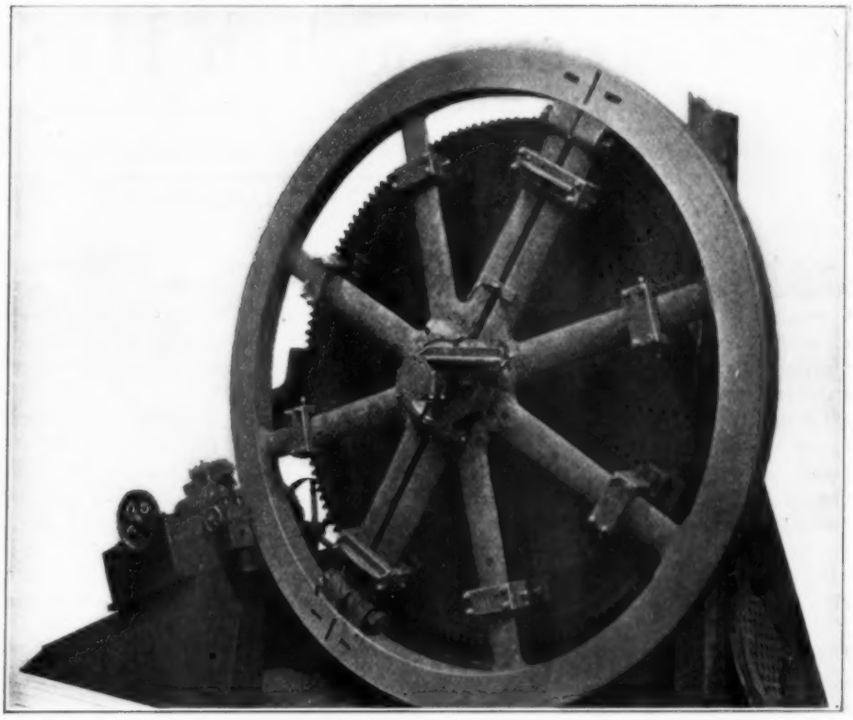


FIG. 3. THE TURNING AND FACING TOOLS AT WORK

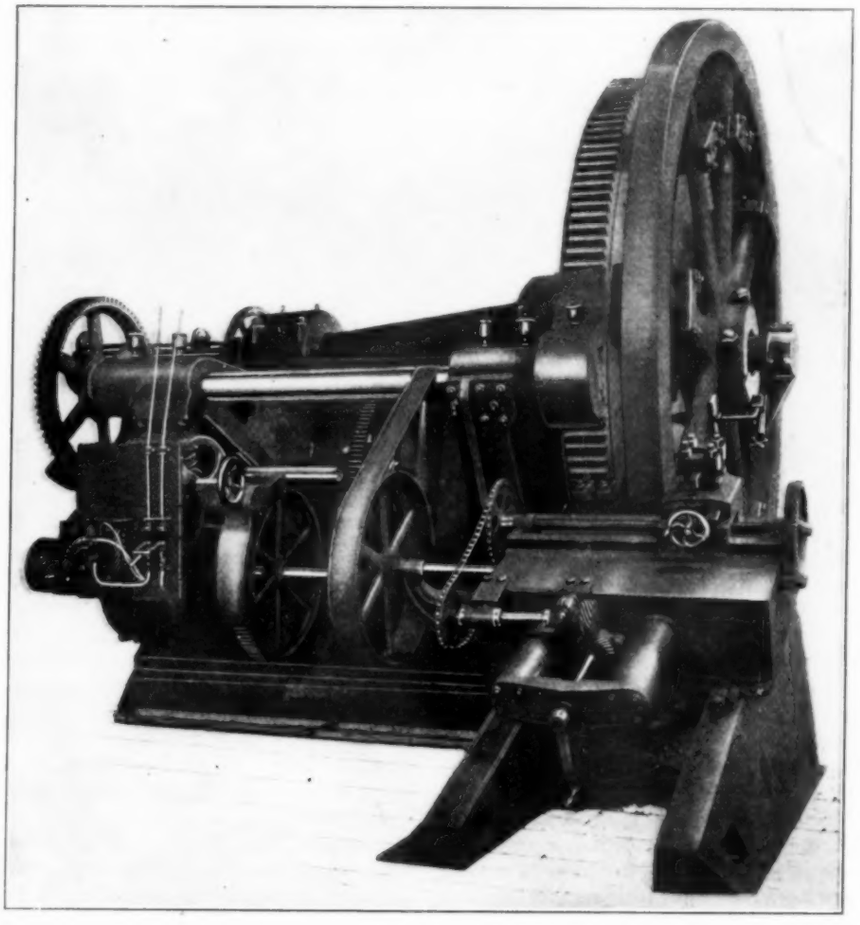


FIG. 2. THE TOOL CARRIAGE AND ITS FEED

Few people have anything like a clear idea of the amount of forest wealth left in this country. Those who think at all about this natural resource which has assisted in material development since the landing of the first settlers are usually too much influenced by the condition of that particular State or section in which they are most familiar. If they live in a much deforested or a treeless region, the people usually imagine that the country's timber supply is even more limited than is actually the fact; on the other hand, with those whose homes are located in a section where a pinch in timber has not been experienced, the feeling is likely to be altogether the other way, and some become so indifferent at times as to think that there is really not much reason to worry about a timber problem. Both can profit by a reading of the actual facts. The forests of the United States now cover about 550 million acres, or about one-fourth of the land of the whole country. The original forests covered not less than 850 million acres, or nearly one-half. The forests owned by the Government cover one-fourth of the total forest area, and contain one-fifth of all timber standing. Forests privately owned cover three-fourths of the area, and contain four-fifths of the standing timber.—*J. of F. I.*

A Modern English Hardening Room

High Speed Steel Furnaces in Detail. Spray and Water Jacketed Quenching Baths. Revolving Air Cooling Stand. Reheating Furnace

BY M. THORNTON MURRAY

In view of the increasing interest which is being taken in the question of steel hardening, in engineering circles, and the numerous articles that have appeared in the AMERICAN MACHINIST of late, a description of a typical modern English hardening room may be interesting. This room is a part of the Messrs. Crossley's motor car works, at Manchester, which is one of the best equipped plants in the country. For purposes of comparison with the up-to-date American hardening room of the Standard Tool Company, of Cleveland, Ohio, which was described in No. 10, Vol. 31, Part 2, of this paper, it may be of interest to the readers. For the accompanying illustrations, I am indebted to the courtesy of W. Turner, the general manager.

FIG. 1. HARDENING ROOM IN CROSSLEY BROTHERS MOTOR CAR WORKS, BIRMINGHAM, ENG.

TEMPERING PLATE

A general view of the eastern side of the room is shown in Fig. 1, with the different types of furnace which Crossley Brothers find necessary for their widely varying classes of work.

The first piece of apparatus on the left is a 16 by 24-inch tempering plate. It is built upon an iron pedestal, in order to give it greater firmness, while a wrought-iron oven, with a large sliding door, which is constructed over the heating plate, keeps away drafts, and secures a higher and more uniform temperature than is the case with an open plate.

As will be seen in Fig. 2, which is a larger view from the opposite end, the plate has 6 rows of small gas jets, with 30 jets in each row. There are also numerous small pins projecting downward from the bottom of the plate and cast to it. This arrangement holds the heat to and spreads it evenly over the bottom, so that all parts of the top of the plate will have a uniform temperature.

QUENCHING VAT

The large circular vat, seen next in Fig. 1, is a special device for quenching cutters, when hardening. A detailed drawing of this is shown in Fig. 3.

A circular pipe *B* is fitted at the base of the outer casing *A* and from *B* rise short vertical pipes *C C*. In each of these are bored two parallel lines of slanting holes, so arranged that when water is forced around the circular pipe, and up the vertical ones, it is delivered from each pair of holes as diverging jets, as shown by the lines at *D*. The effect of this is to produce a cylindrical cooling zone, bounded by the vertical pipes, and filled wholly with spray.

The water is thus maintained at exactly the same temperature, even when the largest pieces of steel are quenched, while unequal hardening, which is the greatest drawback of ordinary spray quenchers, is entirely obviated. This cooler is used especially for cutters, but is applicable to almost any kind of work.

WIZARD HIGH-SPEED STEEL FURNACE

The furnace which may be observed next to the quenching vat, is a gas furnace designed especially for treating high-speed steels. A larger view of this furnace is shown in Fig. 4 and a sectional view in Fig. 5. Its chief peculiarity is in the manner in which the flame is introduced into the furnace.

Two horizontal burners, each conveying air and gas in concentric tubes, enter the furnace on opposite sides, and at different levels. By an ingenious arrangement of channels in the lining of the fur-

nace, the flame is given a rotary motion, with the result that the whole of the interior of the heating chamber is filled with flame, which passes round the circular walls of the chamber, at a high speed, and out through the flues at the back. Hence the products of combustion pass to the exhaust box, which is located under the actual furnace.

Through this box pass the pipes conveying the incoming gas and air, so that a regenerative action is set up, and as soon as the furnace is in blast, both the gas and air are pre-heated.

This furnace is made by The British Gas Furnace and Tool Company, Birmingham, Eng., as well as are all the furnaces in this room and most of the other apparatus. It has been aptly name the Wizard.

With this furnace a temperature of 2500 degrees Fahrenheit can be attained in twenty minutes, and maintained at that figure upon a very low gas consumption. The blast-pressure generally used is about 2 pounds per square inch. Though usually confined to small work, the furnace can be used for larger articles, as an opening at the back allows for the introduction of long bars, or drills.

One of the great advantages of this furnace, is, that it minimizes scaling, the

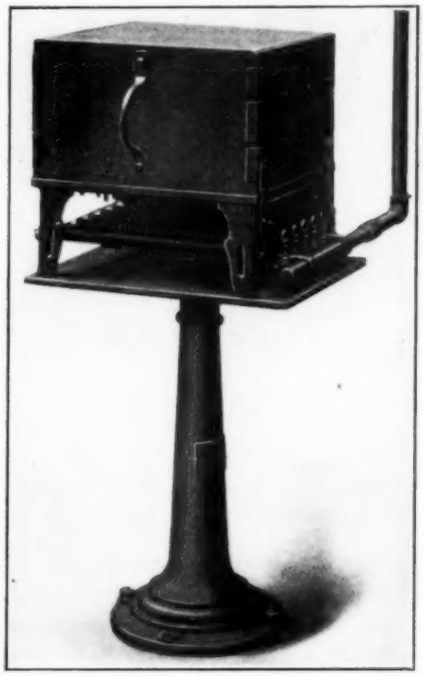


FIG. 2. TEMPERING PLATE WITH WROUGHT-IRON OVEN

whole of the interior being a vortex of burning gas, which prevents the entrance of the outside air, and renders the furnace atmosphere a neutral, or reducing, one.

On account of the high temperature attainable in it, the furnace is often used for heating lathe tools, previous to forging, these taking the place of the blacksmith's hearth. It is very much cleaner for this purpose, besides being a great deal more convenient.

Air Hardening Table

Most high-speed tool steels, and other special steels are now air-hardened and Crossley Brothers have installed a special hardening table for this section of their work. This is seen to the right of the high-speed steel furnace in Fig. 1.

A revolving disk is fixed on the center of the table, which is of cast iron, with cast-iron supports, and tangential air blasts are introduced through two adjustable nozzles. The hot metal is placed on the disk, the air blast turned on, and the disk revolved.

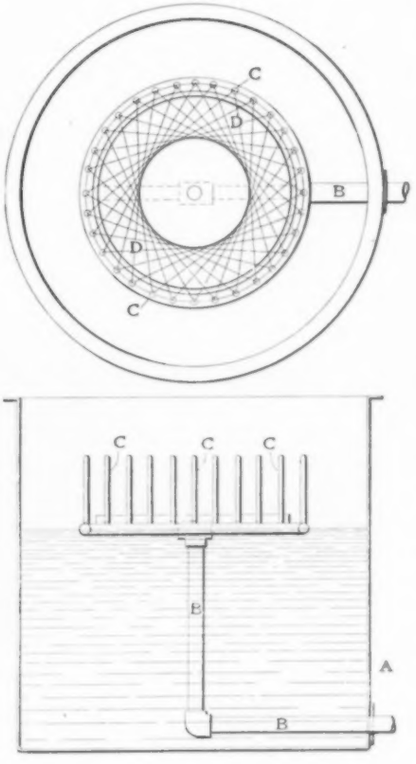


FIG. 3. WATER SPRAY QUENCHING VAT

By this means a uniformly hard tool is turned out, with a total absence of those internal strains that are usually set up by unequal cooling, and which are especially liable to occur in special steels.

Vertical High-speed Steel Furnace

To the right of the air-hardening table a vertical high-speed steel tool furnace has been installed. It is shown to the best advantage by Fig. 6. The point of interest in connection with this furnace is the method of introduction and extraction of the steel to be hardened. This is done by a movable fire-clay plate, which can be raised or lowered by means of a rack and pinion. When raised, it forms the bottom of the furnace, by fitting into a circular cavity. By this means, much of the discomfort ordinarily connected with hardening is eliminated, since the hardener need not stand in the full glare of the opened furnace while he extracts the tool.

This furnace has the flame injected into the heating chamber at an angle so it will

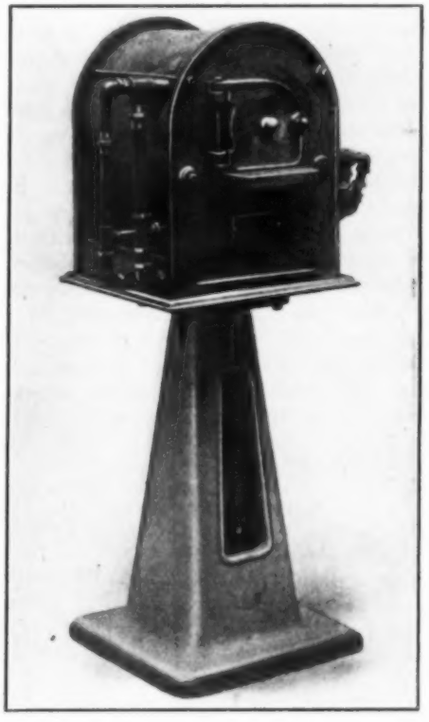


FIG. 4. WIZARD HIGH-SPEED STEEL FURNACE

be given a rotating motion and thereby heat all parts of the chamber uniformly. As heat rises and cold descends the temperature of the furnace is not reduced as much when it is opened at the bottom to insert the tools, as would be the case with a side or top opened furnace. For this reason, also, the flame is inserted near the bottom of the furnace.

With this arrangement the heat in the furnace chamber is raised as quickly as in the Wizard furnace, and is maintained at a more even temperature than in most furnaces. This enables the operator to get very good and uniform results when hardening tools.

The entire top is a cover that is made of fire clay which is held together by a steel band that surrounds it, with handles bolted on to lift it off. In the center of this is a small peep hole with a cover fitted in.

Near this furnace is a large circular quenching tank, to be used for hardening. The tank is thoroughly water-cooled, being wholly surrounded by a water jacket, through which water is continually passing. This prevents the brine from heating much above the temperature of the air even during constant use.

Carbonizing Furnaces

For reheating steel from the carbonizing

furnace the large, gas fired reheating furnace shown to the right of the above described quenching bath in Fig. 1 is used. One of these furnaces is shown to better advantage in Fig. 7. Gas and air, the latter under pressure, are blown in at the back of the furnace, where they take fire. The flame passes along under the floor of the heating chamber, in a space between it and the outer casing, and rises at the sides and front, returning to the vent at the back over the top of the floor. The whole of the interior is at a uniform high temperature, while the absence of flame or smoke makes the furnace very efficient for hardening purposes. Another point in its favor is the saving of floor space. An ordinary coal or coke fired furnace, with its accompanying grate, flues and chimney, takes up about three times as much room as this furnace, which occupies only about 4 square feet. In spite of its relatively small dimensions it is able to cope successfully with the large output of the carbonizing furnace; a task which could probably only be accomplished by a solid-fuel furnace twice its size.

In a separate portion of the shop is located a large carbonizing furnace, for carbonizing mild steel; an important branch of motor engineering. The object of having this furnace in a separate department is to keep the hardening shop itself quite free from coal, coke or carbonizing mixtures, and their accompanying dust or dirt.

The furnace itself is coal fired, and is built on the reverberatory principle, the flame passing along the sides and rising at intervals by ports. By this means a uniform temperature is maintained all over the furnace; a very necessary condition for good case-hardening.

Another point in favor of this method of firing is that the actual flame does not come into close contact with the charge: The walls and roof of the furnace are first heated, and the heat is then radiated down upon the floor, where the case-hardening boxes are placed.

This furnace is capable of maintaining a temperature of about 1850 degrees Fahrenheit for an indefinite time, and without serious variation.

Pyrometers

To guard against any serious deviation from the correct case-hardening temperature, however, a pyrometer is used. This instrument is provided with a recorder, consisting of a length of squared paper rolled on a drum, and provided with a means of registering the temperature at regular, short intervals of time.

A record such as this, where any variation of temperature is indelibly recorded insures good work. Should the temperature have risen too high at any time, or have fallen to too low a figure, no subsequent tampering with the furnace can disguise the fact. Too often, when non-registering instruments are used for this purpose, and the temperature is noted casually every few minutes, a sudden rise or fall, such as would undoubtedly ruin delicate work, passes unnoticed, and poor results are ascribed either to bad steel, or to an unsatisfactory carbonizing mixture. The real cause of the difficulty, however, has been ignorant or careless firing.

The pyrometer used is a Féry radiation pyrometer, invented by M. Féry, of Paris. This pyrometer may be either connected to the recording instrument, or to a Meylan d' Arsonval galvanometer, such as is usually supplied with the pyrometer, by the Cambridge Scientific Instrument Company, An optical pyrometer such as this, is peculiarly adapted for use in the hardening shop.

When an ordinary thermo-couple instrument is used for ascertaining the temperature of a hardening furnace, incorrect results are often obtained because the steel which is being heated is at a lower temperature than the furnace itself, when the pyrometer dial indicates the right quenching temperature.

The Féry pyrometer is focused directly upon the steel itself, and the true temperature of the material is obtained. The workman is thus enabled to turn out the most delicate work with the utmost certainty that it has been correctly heated, and will be properly hardened.

Air Supply

The air blast for the whole of the hardening shop is supplied by two positive-pressure blowers, each blowing at about 4 pounds per square inch. The utility of having two small blowers instead of one large one is obvious, since when only a portion of the furnaces are in blast one blower can be shut off, and the power necessary to drive it is saved; while the cost of the two smaller machines is not greatly in excess of that of one large one. In hardening rooms this is of the utmost importance, since the demands made upon a single large blower would be altogether too variable to be economical.

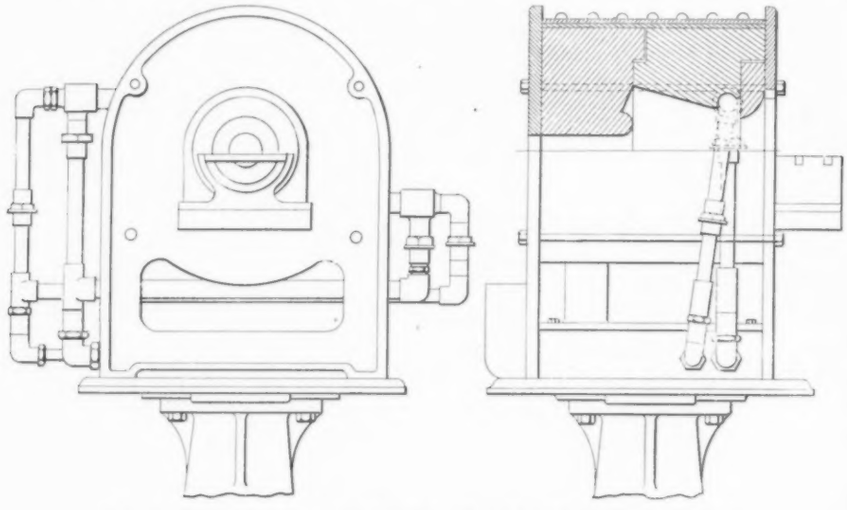


FIG. 5. SECTIONAL VIEW OF WIZARD HIGH-SPEED STEEL FURNACE

FIG. 6. VERTICAL HIGH-SPEED STEEL FURNACE

A Brazing Furnace

A most interesting piece of apparatus, which at first sight might appear out of place in a hardening shop, is a liquid brazing furnace. This is shown at the end of the room in Fig. 1, and a sectional view in the line cut, Fig. 8. It is gas fired, and its installation in a shop where gas, and air under pressure are easily obtainable saved the expense of laying pipes, or installing a separate blower.

The furnace is vertical and rectangular in plan, the brazing metal being maintained in a liquid form in a 12 by 24-inch V-shaped hearth. The products of combustion, as well as any fumes which may

rise from the metal, are collected by a hood, and carried away by a flue. This hood forms the upper part of the furnace.

Borax and boracic acid are added to the bath as flux. The work to be brazed is carefully cleaned (those parts which it is not desired to braze being covered with plumbago) and dipped into the brazing metal.

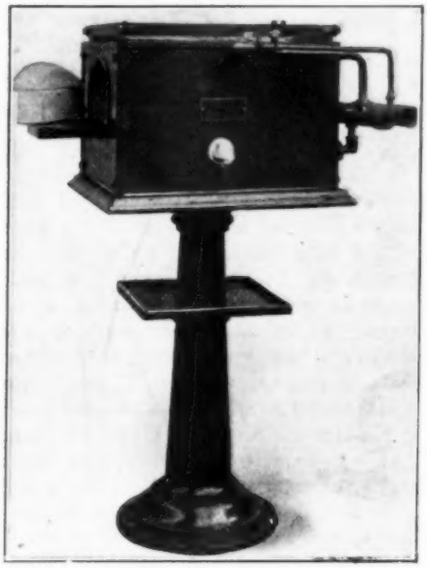


FIG. 7. FURNACE FOR RE-HEATING WORK AFTER CARBONIZING

This furnace has been most successful, and is able to do work which could not possibly be performed by the older methods. I have seen a long internal joint brazed in this furnace in such a manner that it was difficult to distinguish the junction of the two pieces of metal. It cannot, however, be successfully used for loose-fitting or cheap work, which is treated upon an ordinary two-burner brazing table, such as is seen in the corner of the room to the left of the liquid brazing furnace.

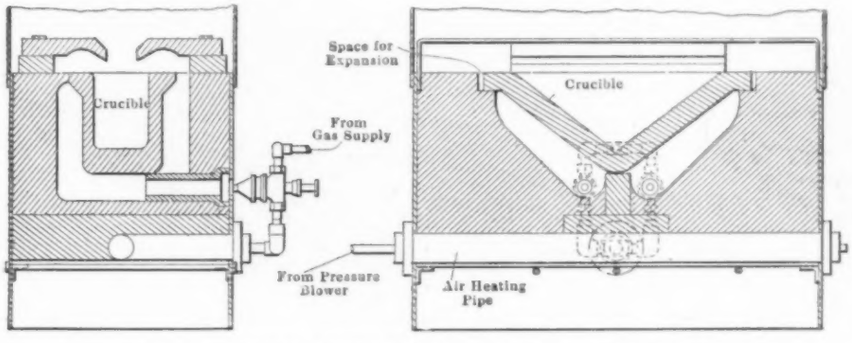


FIG. 8. SIMPLEX LIQUID BRAZING FURNACE; GAS FIRED

Conclusions

The Crossley Brothers believe in plenty of air and space, and their hardening shop is both spacious and lofty. The casual visitor is struck, too, by its clean and orderly appearance. Managers agree, nowadays, that a dirty shop in any part of the factory makes for poor work, and in no part of the works is this belief more thoroughly supported than in the hardening shop. Indeed the hardening shop in most works is too liable to be neglected. Even if pyrometers and other scientific instruments appear too expensive for the man in a small way of business, it will pay him to run his shop on lines as scientific as possible; such can be done by a careful arrangement, and the exercise of a little ingenuity in constructing suitable apparatus.

Hardening by rule of thumb is bound to get left nowadays, as the classes of steel to be dealt with are almost infinite in variety, and specifications bind the hardener to extraordinary accuracy. To large firms who are content, even now, to push the hardening shop back into an obscure, ill lighted, ill ventilated corner, this room should serve as a salutary example.

When they equipped their motor works, the Messrs. Crossley were determined to have everything done in the most up-to-date style, and they intrusted the whole equipment of their hardening shop to a firm of hardening-shop specialists, The British Gas Furnace and Tool Company, Ltd., of Birmingham, who took the matter in hand, and fitted up the shop as I have described.

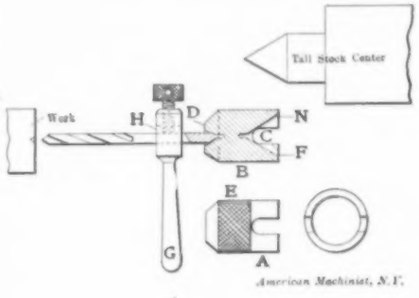
Magnetic Drill Center

By G. J. Murdock

The device shown in the sketch herewith was made some time ago for my own use, and I have found it so handy and so time saving that I think it will be found by others an extremely useful little tool, and one that can be easily made, as well as taking up very little room in the tool chest.

A represents a side view of the device, and *B* is a section. It is of round tool steel nurled at one end so as to be easily held in the hand and is provided with female centers at both ends. The center *C* is larger than *D*, and reamed to a 60-degree taper so it will fit the lathe tailstock center. The center *D* is made the same taper as the chuck end of straight shank drills and will take any size drill from No. 60 up, but the device is especially intended for sizes from No. 1 to 60.

After it is finished with the taper female centers so that they are perfectly in line axially, and nurled at *E*, a slot *C* is milled into the end *F* with a convex milling cutter, and the tool is then hardened as hard as it is possible to make it. After hardening, the end *F* is lapped on a 60-degree center until it has a perfect



MAGNETIC DRILL CENTER

bearing all around, this only being necessary if it has gone out much in hardening, which can be easily ascertained by well known means.

The next thing to do is to magnetize it. This should be done by placing one leg, say *F*, on a strong electromagnet, which can be found around the electric apparatus in almost any shop. Care should be taken to place one leg only on the core of the electromagnet where it may remain a few seconds, which will convert the tool into a powerful permanent horseshoe magnet of which one leg will be the north pole, while the other will be of south polarity. The purpose of this is that when the device is placed on the lathe center it will stick, which it will do, as the lathe center will act precisely as the keeper does on an ordinary horseshoe magnet, and when the drill is taken away from the end *D* it will not fall off the lathe center, but will stay there until pulled away by the hand.

A lathe dog or a small clamp can be used to keep the drill from rotating with the work to be drilled, but I have found the handle *G* to be very useful for this purpose, and it is an easy thing to make. The hole *H* is made as large as the largest drill it is desired to hold, and the set screw is nurled and can be turned down by the fingers to hold the smaller drills. For changing drills where several sizes must be used in the same hole this will be found especially handy as the drills can be changed much quicker than they can where a chuck is used. It often happens too that it is desirable to use the lathe center immediately after the holes are drilled, and this device is quicker and easier to remove than a chuck.

The Patternmaker and the Foundry—II

Comparisons between Solid and Open Frame Patterns and between Solid Box Patterns, Cored and Skeleton Patterns, as Regards Cost of Patterns

BY PATTEN MOLDE

The patternmaker familiar with the actual operations of molding, and the details of general foundry practice, can readily understand why in many cases a skeleton or open-frame pattern is preferable to the full or complete pattern for the job intended. It is not always because of the saving in pattern-shop expense, though that should be considered, but it is to be preferred in specific cases, because of its greater convenience for the molder, and because it enables him to produce a better casting, at less cost, than would be possible from a full pattern.

At the same time it is difficult to convince others that are not familiar with actual foundry practice that such is the fact; for why should a *part* of a pattern be better than the *whole?* The answer is, that in making patterns we are but making tools for the molder by the use of which he can produce the required object. These may take the form of the object itself, or may differ from it, in appearance, so much as to be unrecognizable by those not intimate with the methods of patternmaking.

Foundryman's Patternmaker

These tools or patterns may give the form desired by an arrangement of boxes for cores without any pattern proper so called, or by a combination of the two; or the form of the object itself; or only a section of it. That which is the best means for producing the object required is true patternmaking, and meets the requirements of the present-day demand for a foundryman's patternmaker.

There are many patternmakers that have failed to acquire this knowledge of actual foundry operations either because of a lack of interest, or because of a lack of opportunity for observation. This may be on account of the very stringent rules of some manufacturing establishments that forbid visiting, or even access to departments other than the one in which you are employed, or because there is no foundry connected. In other cases it is simply lack of experience, which time will supply. The two examples given in this article are chosen simply as typical of many others that may be cited to confirm this argument.

Open-frame Patterns

In Figs. 1 and 2 we have two views of

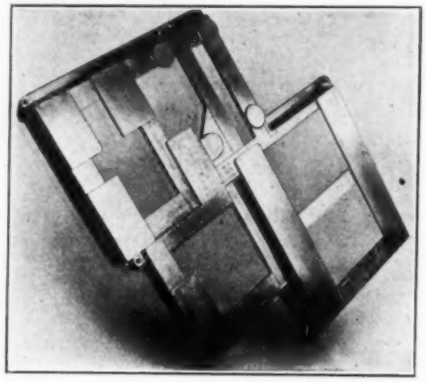


FIG. 1. OPEN FRAME OR SKELETON PATTERN

an open-frame pattern, for a solid base plate. In Fig. 1 it is set up on edge to better show the face of, and the openings in, the pattern; while Fig. 2 shows the reverse side. This is the position in which it is molded. Sweeps *A*, *B* and *C* are shown in place for striking out the sand to the metal thickness. This view also shows the construction of the stiffeners or ribs, which are stacked up at the rear. The half-width notches, that enable them to straddle each other, and also give them their proper location on the pattern are plainly seen. Those having only one notch are held straight by dowels at the ends. Fig. 3 shows the pattern with the sweeps removed and the ribs set in position.

This pattern would require a flask at least 9 feet square to contain it, the depth of the pattern being 7 inches.

Solid Patterns

I have seen many similar castings to this made from patterns having the plate solid and being in all respects the shape of the required casting, except for the core prints; but I have never seen what might be termed a perfect casting among them. All of them were more or less strained at the center; some so much so that, in planing, the central finish pads would cut all away and into the solid plate.

The reason for this is that to make such a casting from a full pattern under the best conditions would require a full flask, both drag and cope. These are generally used with a wooden bottom board, which in this case would be 9 feet square plus the thickness of metal in the flask. This being clamped to the flask around the outer edges, even if fairly well supported at the center, will yield or sag some under the pressure of the metal when casting. This would also be true if an iron plate is used instead of a bottom board, unless it is ribbed up more than usually strong.

Another consideration is that the cost of such a flask would be high if correctly constructed for the best results. This cost could only be justified on the supposition that enough castings would be required to make it profitable, which is unlikely.

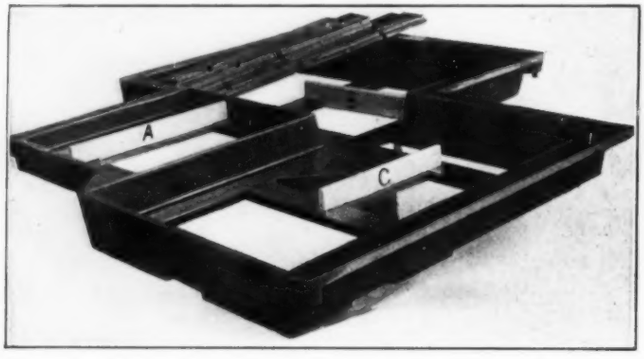


FIG. 2. PATTERN WITH SWEEPS IN POSITION

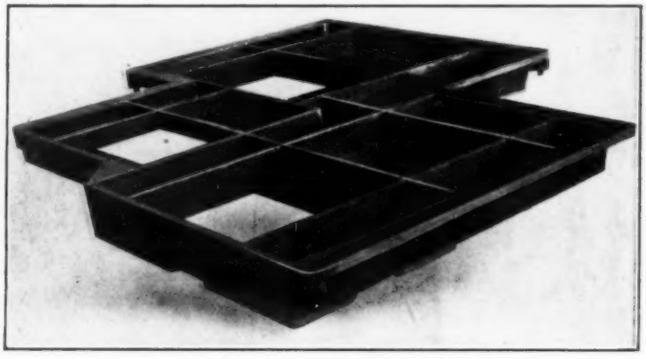


FIG. 3. PATTERN WITH RIBS PLACED READY TO MOLD

Molding Solid Patterns

To lift and roll over a fairly good flask of these dimensions, without twisting or jarring it, is not a very difficult job in a well equipped foundry with ample head

room, but these castings must sometimes be made in foundries lacking in both of these essentials to success.

The alternative is to bed the pattern in the foundry floor, and to do this properly with a full pattern is not easy for the molder. If he makes his bed level to start with, as he must if it is to be correct, it is more than likely he will make it *soft* in order to *"pound"* the pattern into it. This is hard on the mold and on the molder, but particularly hard on the pattern. It is also indirectly hard on the patternmaker, whom you know, should make a pattern that will stand anything in the way of abuse, but sometimes finds it difficult to do so.

The molder having now got a partial impression of the finish pads, the pattern is located by stakes driven in the sand, at its outer edges, to insure its return to the same place. It is then removed, the mold scraped out some, the pattern replaced and given another pounding, with probably another try out and replace. Then the ramming of the outside, and the making of the cope is proceeded with. When the molder vents and finishes the under face of the mold, which must be done after the pattern is withdrawn, he will doubtless find a number of soft spots that must be patched up. The whole surface must be gone over, which is double labor and the result is usually a lumpy, uneven face on the casting.

Molding Open-frame Pattern

With the pattern shown in Figs. 1, 2 and 3 many of these difficulties are avoided and it can, if desired, be bedded in a flask about as quickly as it could be rammed up and rolled over. It is better, however, to do away with the cost of the drag half of the flask and the bottom board or plate, with its tendency to sag, and to make the casting in the floor.

When made in the floor the first thing is the digging of a hole of sufficient size to contain the pattern and allow room for ramming sand around the outside and from 16 to 18 inches deep. This will allow from 3 to 4 inches for a cinder bed, a safe ramming of sand above this, and keep the top edge of the pattern level with, or slightly below the floor line of the foundry.

The cinder bed, as its name indicates, is a layer of cinder, or crushed coke, beneath the mold so as to form a free passage for the gases generated when pouring. One or more outlets are provided by piping to a point above the floor level and beyond the limits of the cope flask.

Above this cinder bed is rammed about 5 inches of sand, in this case. If the mold is to be made from a full pattern this must be leveled off true, and the surface not rammed too hard, otherwise it would not be possible to pound the pattern into it.

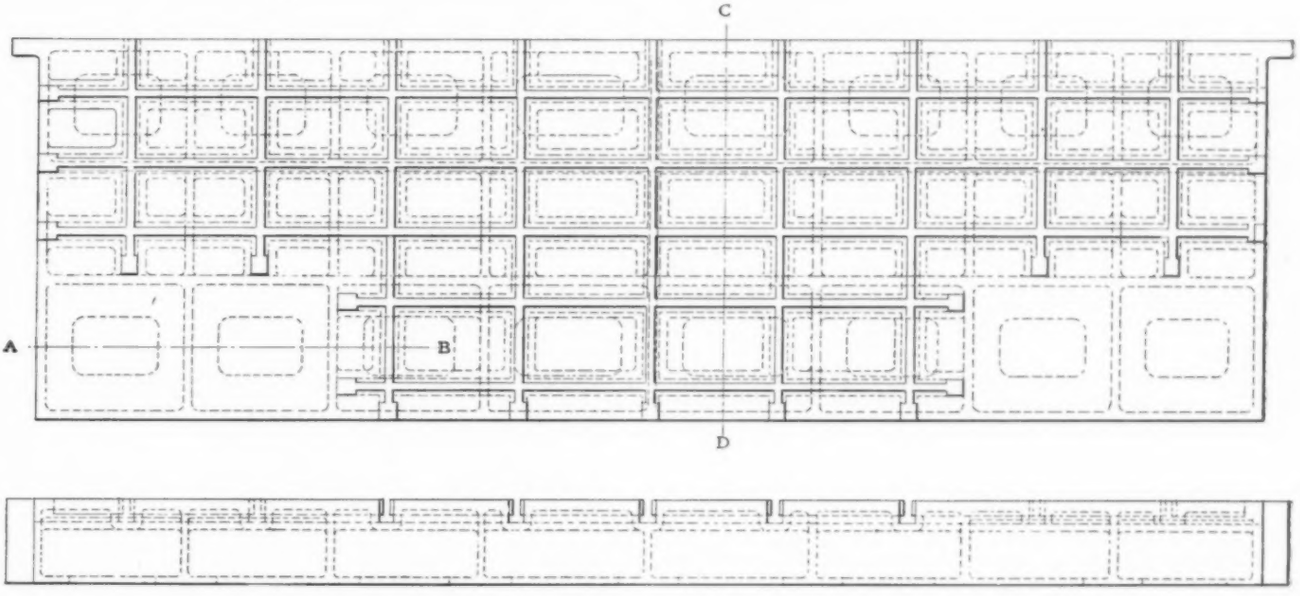


FIG. 4. PLAN VIEW AND SIDE ELEVATION OF CASTING FOR HALF OF A BASE OR FLOOR PLATE

Ramming and Venting

In the case of an open-frame pattern, it is not necessary to spend any more time leveling this sand than is required for ordinary ramming. This can then be rammed solid and vented freely with a heavy vent wire passing through to the cinder bed. The vents or passages may be closed at the top by a slight pressure and later connected with the surface of the mold by a fine vent wire.

When the ramming is completed the pattern is blocked up in a level position and the parts under the frames tucked under with a special facing mixture. The openings in a skeleton or frame pattern make these parts easy of access.

The tucking done, and the blocking having been removed, the sand is rammed to the top of the pattern on the outside, and to the top of the plate on the inside. The sand is then struck off level, for the cope flask, and the loose ribs are set in position as shown in Fig. 3. After sprinkling with parting sand, a layer of facing is thrown on the pattern, and the cope flask is lowered into place. This is secured at the corners by stakes driven into the sand in such positions as will insure the flask returning to the same spot after being removed. Gaggers are carefully arranged to support the deep pockets of sand between the ribs, and the ramming is then continued until the cope is filled.

The cope is then lifted off, and may or may not be rolled over for finishing purposes, according to the facilities of the foundry, and the wishes of the molder. With the ribs arranged, as in this example, so that each one can be drawn individually, it would be unwise to take the risk of disturbing the sand by jarring the cope. The ribs being drawn separately it leaves very little overhead finishing to be done after the cope has been set on horses of a convenient hight.

After the cope is finished the sand is scraped out of the openings of the pattern, about ¼ inch below the metal thickness, and then filled to the under side of the plate with facing. This is then struck off with strikes *A*, *B* and *C*, as shown in Fig. 2. This done, the pattern is withdrawn, the mold finished and assembled, the gate, pouring basin and blowoff arranged, the cope weighted down, and the metal poured in the mold.

Advantages of Skeleton Pattern

The first casting made from this pattern was as near perfection as we can expect to reach in a foundry, and there is no reason why the others to follow should

not be equally good. This mold was left closed until the casting was thoroughly cold.

There is another distinct advantage sometimes in a skeleton pattern that is often regarded in the pattern shop as a defect rather than an advantage, and that is its flexibility. In the pattern shown this is not much of an advantage, because the metal is somewhat evenly distributed, and there is not much of a tendency to warp.

In this case, however, the center of the casting was slightly depressed, because in cooling the heavier metal in the plate pulls the outside down. If this disparity between the thickness of the plate and the thickness of the outside walls and supporting ribs was greater, the tendency to warp would be increased in proportion as the disparity was increased. To overcome this the camber in the mold would have to be increased, or the design changed if the result was to be a straight casting. With a skeleton pattern this adjustment could probably be made by the molder, but with a rigid pattern the camber would have to be worked on the pattern.

Two Methods of Making a Pattern

In Fig. 4 is shown a plan view and side elevation of the half casting of a base or floor plate that is 21 feet by 12 feet 6 inches. Fig. 5 shows a part of the longitudinal section on line *A B* of Fig. 4, and Fig. 6 shows a cross-section on line *C D*. These are shown for the purpose of contrasting two methods of making the pattern for this, or similarly designed castings.

The pattern for this casting was constructed as shown, in part, in Fig. 7. It was boxed up solid for the full length and had the prints for the T-slot cores nailed on tight, the cores being held in position by chaplets between these and the cores above. This method proved very inconvenient in practice, and costly in the amount of time spent on the job in the foundry, and altogether it shows very little consideration on the part of the patternmaker for the other fellow.

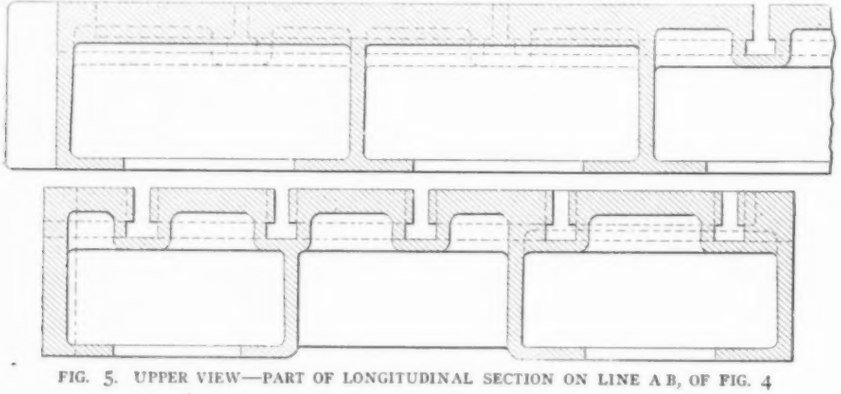


FIG. 5. UPPER VIEW—PART OF LONGITUDINAL SECTION ON LINE A B, OF FIG. 4

FIG. 6. LOWER VIEW—CROSS SECTION ON LINE C D, OF FIG. 4

Contrasted with this we have what may be termed the foundryman's pattern for the same job, which is cheaper in construction in the pattern shop, and much cheaper in production in the foundry. This is illustrated in Fig. 8, which is an isometric projection of one-half the length of the pattern. The pieces at *X X* are for fastening the two halves together when it is used, but for storage purposes it is much more convenient to have it half length.

Core Boxes

The core boxes are not shown as they would be the same in either case, and are of simple design and construction. The main troubles are in the number of loose pieces that have to be changed, and in the marking of the cores. The frames of the box for the two outside runs of cores were made to the largest size and reduced in length or width, as required, by the use of filling-in pieces. A separate frame was made for the center run because of the different depths. The length of this box was also adjusted by filling-in pieces.

It will be noted that the prints for the T-slot cores are shown differently in Figs. 7 and 8. In Fig. 7 the prints are shown the width of the slot for the bolt head. This is a faulty construction, because it necessitates the careful chapleting of *all* the T-slot cores to prevent them from lifting under the pressure of the molten metal. This is remedied in Fig. 8, where the prints are shown wider, and cores properly set in these prints need not be chapleted at all, as the greater surface of the print is covered with the metal and this prevents the core from rising.

Molding the Solid Box Pattern

In constructing any large pattern it is always well for the patternmaker to consider the facilities and tools of the foundry that is to make the casting. Very often this will require the pattern to be differently constructed from what it would be if the foundry was better equipped. These two castings were made in a foundry with a limited crane power, and a very limited amount of head room. In busy times floor space is also at a premium, and these things all tend to aggravate the troubles.

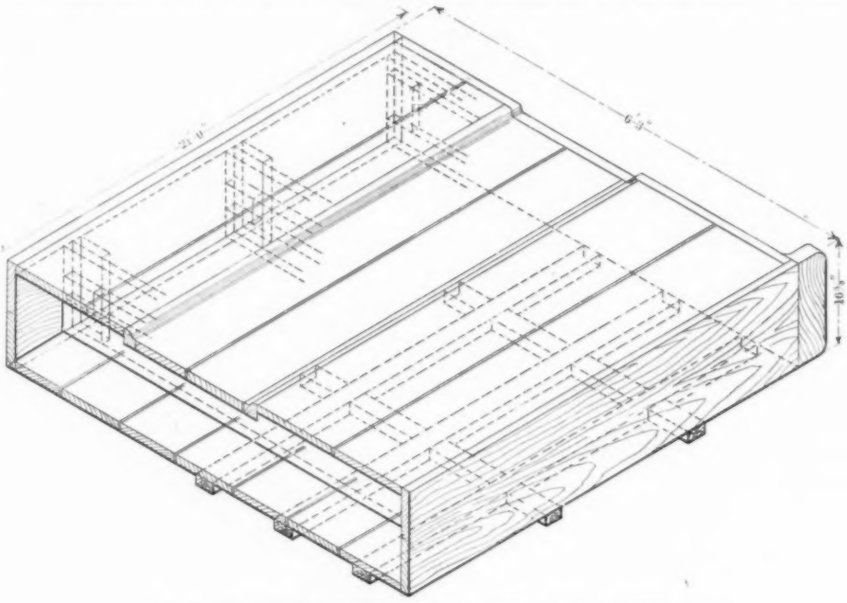


FIG. 7. SHOWING CONSTRUCTION OF THE SOLID PATTERN

With the pattern made a solid box as in Fig. 7 the only way to make the casting conveniently would be to make it in a flask and roll it over. This with the facilities at hand was well nigh an impossibility, but even if it had been convenient, why put the foundry to the expense of the flask when it is possible to make it better and cheaper in the floor? The mold could be covered with a cope, or copes, as two or three stock copes could be used if necessary to cover it.

These castings were made in the floor, above a cinder bed, with a level bed of sand to receive the pattern. The pattern is large, and rigid, and it is not possible to pound it into the sand, even though a good sized maul be used. The prints are fastened to the under side, crossing each other, and forming a number of pockets at the center of the pattern, and a little thought will show how impossible it is for the molder to form these pockets and get the correct lines in the mold. About all he could do is to tuck the

under side as far in as he could reach on all sides, and let the rest go until after the pattern was finally withdrawn. He must then go over the whole of the under side again and form it as accurately as possible with the aid of a straight-edge and a few loose prints. These are many times ripped off the pattern, but it is much better to have new ones made.

It is easy to see how unsatisfactory this will be even though the weight of the pattern is sufficient to mark the sand for the lines of the core prints and not make it necessary to measure them off. It is also easy to see what a time killer this operation is.

Molding the Skeleton Pattern

These difficulties are all obviated by the use of the pattern shown in Fig. 8. In this case the molder can set his pattern, then form his bed, and vent it, and finish it as he goes along. He works from the inside in a natural position, and not lying on his side in the damp sand and straining himself to reach as far under as possible. The work being easy the mold is also made in much less time.

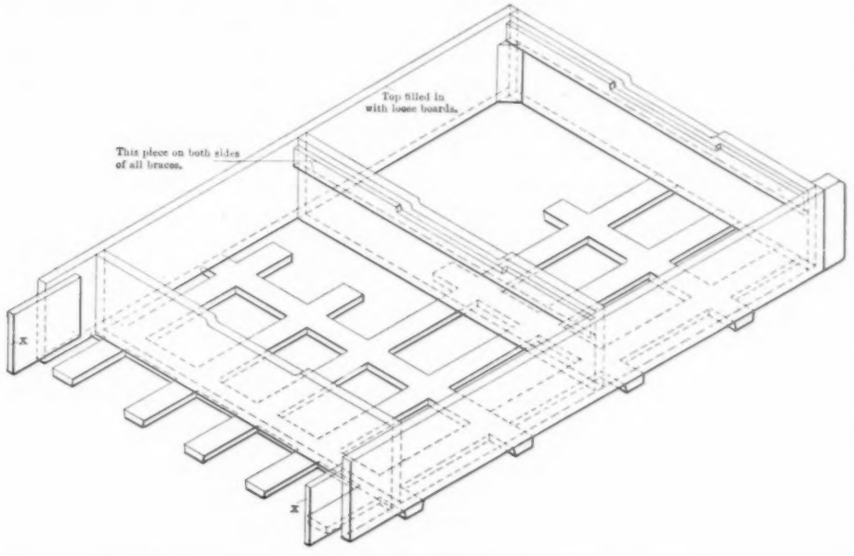


FIG. 8. SHOWING CONSTRUCTION OF THE FOUNDRYMAN'S PATTERN

The under side formed, the outside ramming and the making of the cope would be the same in both cases. Loose boards are provided, that set on ledges prepared to receive them, to make a solid top from which to form the cope. If the cope were made in two parts only a little more than half of these boards would be absolutely necessary, but it would be more convenient to have the top fully covered so it would not be necessary to lift off the cope and replace it more than once.

Warping of Castings

There is one other feature in the solid box pattern that calls for criticism: That is no thought was apparently given to the contraction of the metal and its tendency to warp when cooling, especially when adjoining sections of metal vary in thickness, as will be seen in sectional views Figs. 5 and 6.

With this heavy metal on the under side, it was to be expected that the ends would pull down some in cooling, and the actual result was a deflection of 7/8 of an inch. The T-slots run in both directions, thus cutting up the face of the casting was a good feature. If the T-slots had run lengthwise of the casting only, or had the plate been solid, this deflection would have been more.

With the pattern rigid and full length, it was not possible for the molder to do anything to prevent this warping, but with the pattern arranged as in Fig. 8, he could camber his mold any amount that his judgment or experience taught him was necessary to produce a straight casting.

These examples illustrate a few of the advantages of the skeleton or frame pattern for specific cases, and other examples could be cited of a different design, where the advantages would be equally great.

I do not want to be misunderstood, and give the impression that a skeleton pattern is always best, for I have seen them used when they were anything but an advantage or help to the molder. To sum up the matter, it but emphasizes the fact that the patternmaker should make a more thorough study of the foundry with a view to getting at the best results.

The American Consul at Birmingham, reporting on the effect of the New Patents and Designs Act, says that taking the United Kingdom as an entirety, it would seem that the number of American manufacturers who have protected themselves by complying with the provisions of the law is very considerable, and represents a large amount of work taken from American workmen. He also reports that quite a large number of British firms are working American patents under royalties.

American Methods of Education, General and Technical

Much is written about European methods of education. From time to time we see reports in regard to an investigation of this or that school in some European educational center. This is particularly true of the industrial and technical fields. Does it ever occur to us that the reverse process of investigation may be operating? Do we ever think that our American schools are looked upon with favor by Europeans, particularly of the continent, and that they are endeavoring to draw inspiration from our work in the same manner that we are endeavoring to improve our own methods by studying theirs?

That our educational methods are being made a subject of study is shown by a recently published French book, "Methodes Americaines d'Education Generale et Technique," by Omer Buyse. This book shows the result of an extensive investigation of many of our leading schools by the author, and in general is highly commendatory. It is divided into seven sections which treat the following subjects: Elementary Instruction and Books for Children; Secondary Instruction; Institutions for Industrial Training; Institutions for Professional Training; the Education of Race—Negroes and Indians; Commercial Instruction, and Engineering Schools.

Some of our pessimists, and particularly those who decry our lack of industrial education and the lines along which it is developing may be encouraged by a perusal of the conclusions that form the last section of this book. They are of such interest that we have translated them entire.

The American Machinist cannot, we believe, be fairly accused of spread-eagleism. We do not publish the following because we agree with it, our feeling being, in fact, that it is much overdrawn. At the same time there can be no harm in pointing out some of the things which develop in the perspective of distance, and in suggesting that possibly our own admiration of European industrial education may contain much of the same element.

Conclusions

In the midst of the rapid changes in economic and social conditions, confidence in the efficiency of the traditional plan of instruction seems to be shaken in the Old World. A constellation of modern philosophers has made a thorough analysis of the science of education. Their work has filled the mind with distrust and has produced anxiety in the minds of our educators who have been overwhelmed by the new theory.

The work and the statistics of these authorized economic investigators tend to show that the prosperity of a country depends above everything else upon the in-

telligence and energy of its people. They cry out, develop energy! What school will at last prepare the generation for a struggle for the conquest and preservation of their well being?

The conclusions of these debates and investigations of the Universal Congress show very clearly the injury arising from the misadaption of all forms of instruction to the needs of modern life. Our academic structure is indeed submitted to a careful survey, in regard to primary instruction, in the secondary grades, in its higher departments, as well as in regard to its industrial and professional interests. The committees charged with these important responsibilities will give stability to hopes that are as yet vague, and, supported by public opinion, they will draw up in a judicial manner the reforms toward which the true knowledge of education and our well understood national interests are bearing us.

In the seven books of this exposition, we bring some material which is somewhat crude, borrowed from the industrial and commercial people of the United States, which has adapted its method to the needs of the times and has made it of use in its economic growth. In the life of a nation, all forms of education are connected one with another and the results are all related. Nothing can be done to modify the results of teaching, or the entire operation of instruction if some harmonious changes in each round of the academic ladder are not brought forward. For that reason we have made our deductions in all domains of public instruction.

Aided by graphical representations, from all this material the reader will have evolved the laws which govern general and industrial pedagogy. He will have given the professors a share in the formation of a virile and original personality which constitutes the American type. The school of the United States is a creation of the people. The Anglo-Saxon spirit is recognized. The spirit which gives it life is neither historical nor a matter of convention. It is logical and natural. It speaks for the new and the progressive. If any central organism enacts uniform rules, the public spirit in revenge courses through the limbs of the academic body, quickens it and fits it for action.

The schools of all grades are centers of education; in Europe they are places of instruction. The Federal Government, as the individual States and towns, has its board of education. We have our committees of public instruction, administrative boards and ministers of public instruction.

The European sends his children to school to learn something there. The American asks the school to guarantee the entire education of the child, physical, intellectual and moral.

Ideas concerning the scope of the nation's activity in regard to instruction are in the background in our schools. The limits of instruction are fixed. Methods seem to be related to abstract ideas; reasoning purely logical and results gotten from syllogistic reasoning. Subjects are taught by conventional means which seem to depart as much as possible from real life. Questions such as concern organizations, educational movements, educational programs are discussed only in private circles. The people do not understand the language of our pedagogues. They remain strangers to and are indifferent to those discussions which are the business of professional men and men officially appointed for that work.

In America, on the other hand, every school has its own pulse. All of the great questions which have to do with the country's good in the way of science or classics are constantly discussed in their books, reviews, papers and particularly in the meetings and congresses in which the people are associated and interested. The new things which come to life are noted, tried out and put into execution. The public, which is brought into contact with the classes, studies and laboratories, takes part in bringing about results and makes known its satisfaction. From this impetus social and economic life has an entrance into the domain of education and studies receive thereby a freshness and a fascination that is rational and true. In all instruction, the thought and its realization are indissolubly connected. The mind of a child and youth is reached by means of an educational process that is both active and stirring.

The American believes too, that the future of his country is in the hands of the woman who transmits the education that she has received to those who follow. Thus, while the schools of Europe are taking only the smallest share in the intellectual life by means of a boarding-school education, which is artificial, and by instruction which is restrained and hampered in the secondary schools, which are poorly attended, all the American institutions of learning are filled with young people, poor and rich, who come there to be educated; intellectually by literary and scientific study, and professionally by studies of cuisine, economy and the domestic arts. Cuisines and studios of domestic science in connection with these schools are really laboratories, in which the bride of the future acquires by practical means the inclination and knowledge necessary to assure her own independent existence and to increase the physical and moral strength of the nation.

Naturally our ancient traditions carry us toward an altruism which exalts itself in great works of philanthropy, such as are of mutual help. These works are palliative, but they have a tendency to hold back the masses from helping themselves. Americans, they are called individualists in the extreme, make use of a joint method, less sentimental to be sure, but more efficient. The towns, as well as the individuals, contribute money generously for the maintenance of fine libraries for children and adults and become rivals in their gifts to educational institutions and to all works of charity. This form of beneficence seems to us equally noble and is particularly propitious in the social and economic progress of the country.

The school should offer an equal chance to all to acquire in a practical manner the fruits of higher education.

The ideal of education which arises from this great national motive is simple and democratic.

The school should offer an equal chance to all to succeed and should offer in a practical manner the means for acquiring the advantages of higher education. This purpose as a fundamental, governs the method of instruction in the public and technical schools of the United States. The Americans reproach us for our method in educating children for definite trades. The son of a miner is destined to the mines, the son of a weaver takes up the trade of his father and his hopes do not go beyond the trade of weaving. The child of a European artisan enters, very often, the task prepared for him at his birth and specializes in the trade schools following out a general rule. Such training conflicts with the American idea, which desires the public school to place no barrier in the way of the child's development and opens up the avenues of access from the base to the very pinnacle.

For the same reason, the various steps of education are built the one on the other with a simplicity which the European system may envy. Maternal training, the primary and secondary schools, the colleges, the engineering institutions, the universities, the normal schools, all are a part in the harmonious whole where there is not the least gap nor overlapping.

"Free to the People" is inscribed on the front of libraries and public schools. In order to raise the burden of the thousands of young people who aspire to the higher education and who are without resources of their own, class instruction is given without charge. On leaving the elementary schools, those who must gain a livelihood immediately find in the night schools and also in the industrial schools, well arranged courses, which will prepare them for the college or start them to grasp the scientific and technical principles useful in their work. Entering these institutions at the age of 18, they get an education and at the same time earn something to support themselves by their own work. From this time on nothing stops them from attaining the summit of scientific and technical knowledge.

This course has been followed by a number of men who shine in the front ranks of political, industrial and com-

mercial positions in the United States. This is the path of the strong, of the well lived.

In a few of their secondary evening schools, the United States takes hold of the otherwise waste and undeveloped portion of national intelligence and restores it to a position of worth. The abler ones taken from every class of society bring an extraordinary vigor into industry and commerce. These encouragements to individual growth, upon which are modeled the academic organization, open the way to any intelligent young man who has a will and perseverance. They destroy social stratification into horizontal planes and preserve individual differentiation only in vertical planes.

Following the same idea, instruction in all stages is ruled by a desire to guide the individual to his complete development. This fertile system rests upon a complete knowledge of the child and the youth. American education is conceived as a means of forming character, of developing complete men, sure of themselves, confident of their power, and fitted for independent life. It knows nothing about set instruction or the hampering of intelligence which belongs to our regime.

Our schools appear to us as gardens in which the trees are pruned by the fastidious arborculturist without any care for the species, who cuts carefully every sprout and branch which departs from a given direction or has exceeded the assigned level. They carefully build up the hedges, and even seem to have a partiality for the set lines stretched along the ground. Their one type seems to be a stiff rule of uniformity and symmetry founded on regulations, prescriptions and traditions. The American school reminds one of the forests of Pennsylvania, which grow up from the fertile earth in full freedom; the delicate birch, the tender beech and the oak with rough bark and powerful branches; the wise forester leaves for each individual, a necessary amount of space for its full and free development.

The European school bears witness to a serious ignorance of child nature. It practices the fashioning of brains shamelessly; it suppresses originality and sends newborn personality through the rolling mill. The American school exalts individuality, allows it to show forth its own qualities by a system of work in which the pupil preserves his freedom of appreciation, his own discernment and original thought or action and his responsibility.

The work of this character takes up three-quarters of the time assigned to the curriculum. The teachers are ingenious in giving to literature, mathematics, geography and history some touch of personal research. The method of instruction in the sciences in its very simplest form in the primary, industrial and professional schools as well as in its more difficult forms in the secondary schools and in the technical institutes, hits on a character which makes use of the initiative and self-thought of a pupil at every point. In the public schools, technical branches, designing and mechanic arts assume, with an unbroken continuity, an experimental character which results in inventive exercises and physical and moral development on the part of the children. This work develops a constructive sense in the mind of the child and the youth. It gives from a personal knowledge a clear idea of equilibrium and unity in action necessary to attain to a given end and makes possible the acquisition of ideas of proportion and of symmetry. It points out a series of the laws of physics, it gives free play to the imaginative and inventive faculties as well as a certain knowledge of materials and forces.

In the industrial schools and in the technical colleges the manual work, drawing, and the technical exercises are pervaded with the practical side of the worker's profession, but they emphasize the personal equation of the individual and tend to give to the youth a precious store of methods and experiences. Nowhere is there admonishing and preaching, like the words of a professor placing before them dry, verbal theories, and bringing to their attention the last suppositions of science and technology. Pupils are not seen feverishly scratching down notes, and gathering together in their desks and brains knowledge attained at second hand, received by dictation and reciting without having any element of their own personal knowledge. American schools make these sciences intelligible to the pupil by methods of experimental testing which develop the intellectual faculties and attributes, all the while getting at the source of sane and real understanding.

The lessons do not circle about puny experiments before an audience. The acquisition of knowledge demands that every pupil make use of his ability, tact and sense of combination by means of which he may attain the scientific and technical truths. In work of this sort where the brain is free the pupil comes to possess the habit of observation, reflection and analysis. His mind is disciplined for a calm and prudent struggle in order that by long and patient personal work he may obtain those truths which are his intellectual property. In making the pupil not a passive listener but an actor in the educational life, the American school incites him to be his own instructor, to build himself by his own efforts, to constantly delight in the discoveries made and in the work itself. Furthermore, it develops a quality peculiar to the American nation and well characterized by the word "push," that is the necessity of going ahead in the world at any price. The impatience and desire to succeed, a very high and lofty form of ambition. At every stage of his education, since his entrance into the kindergarten even to the time of leaving college, the young American is led to do acts of initiative. In the course of his studies he accumulates through his intellectual and moral senses a mass of potential energy which he will make use of in his later experiences in all the different circumstances of his life, as his needs make their demands.

It is through these live methods that schools instil into their youth those virtues which make the American people worth while, a resolute and persevering energy in order to *rèaliser l'effort* (get there). These words, full of meaning, placed at the end of our modest work, speak out those qualities which the school should develop and fix in the race in order to make its inheritance proper and to assure growth in the world.

Threading with Worn Dies—Hacksaw for Tubing—Extension Drill

By H. C. Sundell

These "kinks" may be old to some, but that will not detract from their usefulness. I frequently have occasion to use them myself and often wonder how I got along before I knew them.

When hand dies for thread cutting become worn they are generally difficult to start. If the part to be threaded is ground square for a short distance at the end the die will be found to take hold immediately. This will be found exceptionally advantageous with large dies ¾ inch or larger.

Anyone who has used a hacksaw knows what happens when one tries to use a coarse-toothed saw blade on sheet metal or thin tubing. As a fine-tooth blade is not always at hand I find a good substitute can be made by drawing an old blade, still having a full set of teeth, lightly across an emery wheel. This will keep it from cutting too fast.

Of course where much sawing is to be done each tooth may be ground off a little giving it but slight clearance. Still I find the first method very satisfactory.

A very satisfactory extension drill may be had by taking a piece of iron or brass pipe whose internal diameter equals that of the hole to be drilled and with a cross-pein hammer make two dents directly opposite each other and about 1½ inches from one end. Into this pipe drive the twist drill, after having ground the end flat. This is a very good way of driving taps also.

According to the reports of the geological survey, 58,000,000,000 cubic feet of coal gas was made in the United States during 1907 by 513 companies. Of this product 54,600,000,000 cubic feet was sold for $36,327,807.

Limit Gages and Thread Micrometers

The Need and Use of Limit Gages in Plain and Threaded Work and a Micrometer for Measuring the Flats of U. S. S. and Other Threads

EDITORIAL CORRESPONDENCE

While the idea of limit gages is far from being new, a fairly careful consideration of the matter of fine measurements is very apt to lead to the conclusion that their practical value is not by any means fully recognized, and that there are very few classes of work to which they are not applicable. We are all accustomed to the micrometer and most machinists pride themselves on being able to measure and read correctly anything within the limit of the instrument they are using. Yet we are too often made painfully aware of the fact that very few measure exactly alike. If anyone doubts this, he has only to call for a piece of a given dimension from a number of different men, and then test them with some standard gage of almost any type, such as the Swedish gages, which have been frequently mentioned in these columns. A few experiments of this kind will soon convince anyone that there is hardly such a thing as an exact measurement, and if we consider it from the commercial point of view, we are perfectly safe in saying that limits of some kind must be acknowledged and allowed for.

As an example of this, we may refer to the new A. S. M. E. standard for machine screws which contains the mean or nominal size and the minimum and maximum dimensions. After acknowledging the necessity for establishing some sort of a limit, we are next confronted by the proposition of determining when those limits are complied with. If we depend on the micrometer and attempt to measure in each case for the maximum and minimum dimensions, we are still confronted by the variation in touch or feel and it will not take many trials to convince us that this is a very laborious and time-consuming proposition.

In the case of the solid or rather fixed limit gage, we have one with the maximum and the other with the minimum dimensions which are arranged in such a way as to be readily used, and which do not depend upon the accuracy of reading graduations, or on any great amount of skill in touch. If the piece to be measured passes between the first set of points but does not pass the second set, we know the limit of accuracy must be within that called for by the gage, whether this be 1/32 of an inch or 1/10,000 of an inch. While it still remains possible for a piece to be the piece being inspected between the maximum point so as to spring the gage, it is not very likely to occur, and it is surprising how readily we can inspect or measure pieces which are correct within 1/10,000 of an inch above or below a given size. It will pass quite readily between the first or maximum set of points, but absolutely refuse to go between the minimum set.

In the old days, especially on brass work, we used to measure threads with a pair of broad-faced calipers, so as to ride on the top of these threads and find the outside diameter under the fond delusion that we were measuring the threads. Whether the stud fits the nut or not, depends, of course, fully as much on the relation of the angles of the size of the thread as on the outside diameter, and this has led to the adoption of what is known as the pitch line as the proper point of measurement instead of either the outside diameter or the diameter at the root of the thread. This pitch diameter is by common consent in the case of U. S. S. threads, simply the depth of one thread less than the outside diameter of the screw. The V-thread has no fixed pitch diameter and this has led to much confusion among users and tapmakers. Many ingenious methods of measuring threads with ordinary micrometers by using wires which will rest on the angle of the thread have been devised and used very successfully. The thread micrometer is, however, easier to handle than this device, and the thread-limit gage is easier still, where a large number of screws are to be inspected.

The use of limit gages has undoubtedly been retarded by their cost, this in turn being necessarily high on account of the small quantities in which they were made. Believing that they would be much more widely used if the price could be materially reduced, Wells Brothers Company, Greenfield, Mass., has begun their manufacture in such quantities as makes this possible, some of these being shown in Fig. 2.

Among the instruments which have been devised for measuring screw threads

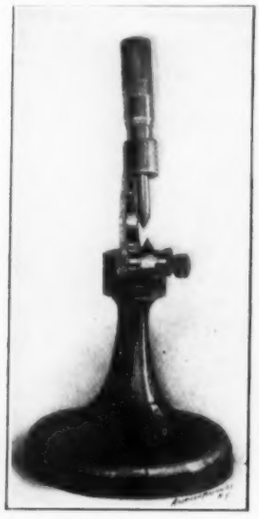


FIG. 1. THREAD MICROMETER

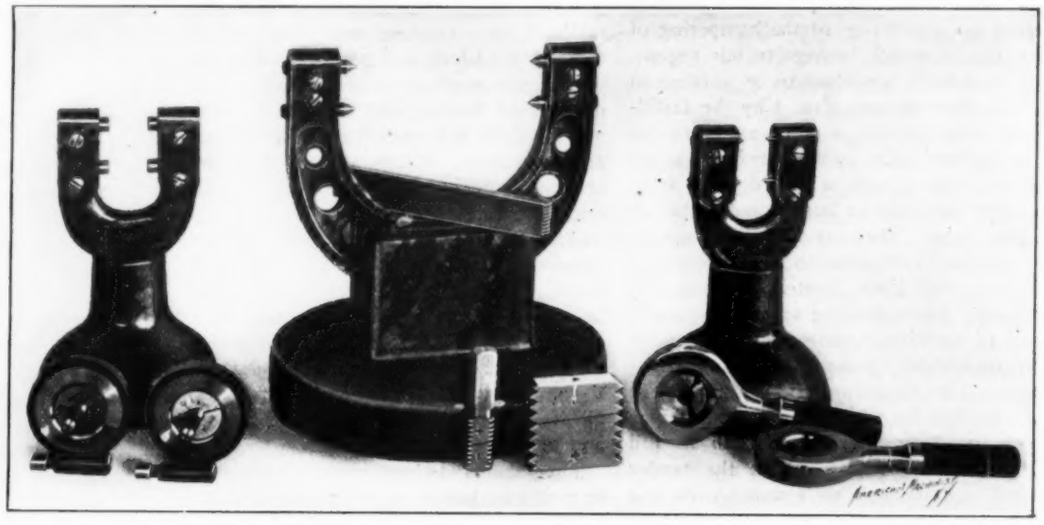


FIG. 2. A GROUP OF LIMIT GAGES

accurately is the micrometer shown in Fig. 1. As illustrated, it is mounted in a stand or base so as to be convenient for use, and at the same time avoid the possibility of distortion or error, due to the heat of the hand on the micrometer frame. In addition to the V-points of the spindle and anvil for measuring threads, the point on the anvil has a cross-movement, so as to secure the exact offset due to the thread being measured; this offset is, of course, one-half the pitch. After being set it can be used as a fixed gage, but does not show the limit of error.

Fig. 2 shows a group of limit gages, two of them being for threads and the other for plain cylindrical work. The small gages in front are being made for the new A. S. M. E. machine-screw standard, one being maximum and the other minimum, and are supplied with hard-rubber protectors to avoid expansion by the heat. The minimum gage is marked by using red rubber, signifying danger if the screw enters here.

In the case of the fixed-limit gages the points are offset the required amount and set by the use of standard pieces, as shown in the foreground. On the two standards in front of the central base will be seen a line, indicating the mean or nominal diameter, and these are so arranged that each thread away from this indicates a variation of one unit, either thousandths or ten-thousandths, according to the desired limit of the work in hand, the plus and minus signs clearly indicating how they shall be used.

become serious if the thread is short, when we multiply it by 4, giving 0.032 variation in 4 inches it becomes very evident, and in this case a variation of very nearly one whole thread at the end of the 4-inch piece.

When we consider that the fit of a thread depends on the bearing of the angular side of the thread, and not

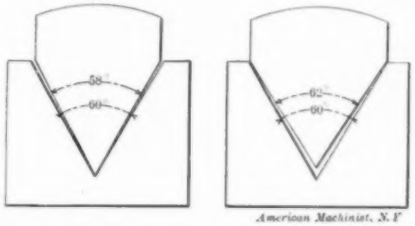


FIG. 4. EFFECT OF WRONG ANGLE OF THREADS

on the top or bottom, we can readily see what a difference in the fit a variation of the angle of the thread makes. This is very clearly shown in Fig. 4, where one thread has the correct angle of 60 degrees, and the other varies 2 degrees in either direction. While threads cut in this way may fit in the beginning by bearing on either top or bottom, this contact soon wears away and a decidedly loose fit remains.

A decided effort is being made by tapmakers to get away from the V-thread on account of the confusion existing in regard to it. As a perfect V is entirely out of the question on account of its meaning a razor edge, and as there was no general agreement as to the amount it should

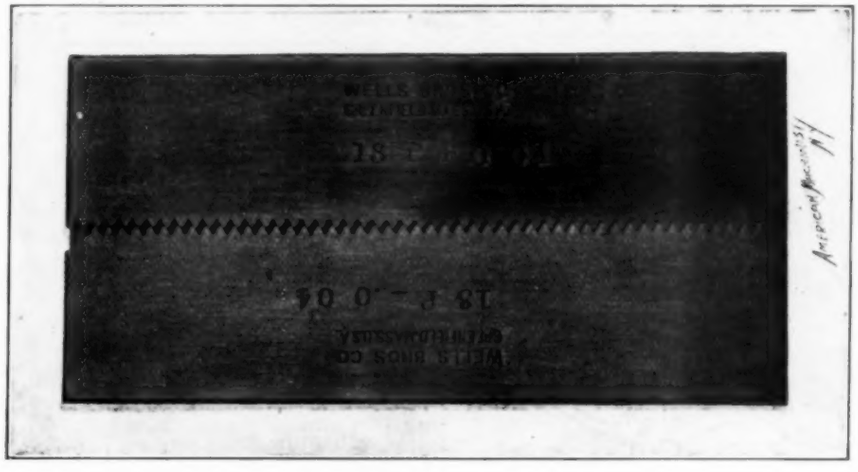


FIG. 3. EFFECT OF INCORRECT LEAD

Those of us who are not directly engaged in this line of work are apt to underestimate the importance of having the angle of the thread exactly right, and also what difference a slight variation in pitch may produce.

As evidence of the latter, we show in Fig. 3 two 4-inch gages of 13-pitch, one made 0.004 too short per inch, and the other varying the same amount in the other direction, making a total variation of 0.008 per inch. While this seems like a very small amount, and in fact does not be flatted, the only practical way seemed to abandon it altogether and go to the U. S. S. thread, which has a fixed width of flat.

Although we know what this flat should be, it has not been easy to measure it exactly, although various devices have been made for this purpose. The solution of the case made by F. O. Wells is shown in Fig. 5, which is a micrometer having an anvil with a 30-degree angle, and an extended portion, on which the measuring point of the micrometer slides. As this point is also 30 degrees we have the thread angle included between them, and the micrometer is adjusted to zero, when the lower points meet and form a sharp V. It is then an easy matter to open this micrometer any desired distance, and in this way secure an exact gage for measuring

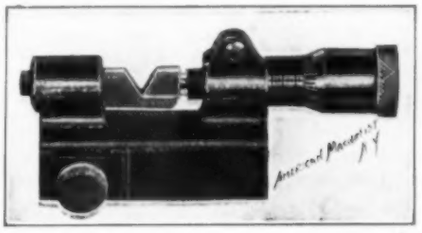


FIG. 5. MICROMETER FOR MEASURING FLAT TOP THREADS

the width of the flat either on the threading tool or the milling cutter, where threads are cut in this way. By substituting points having an angle of 14½ degrees, this micrometer also affords an easy way of measuring the exact width of threading tools for acme or worm threads, and makes a very desirable addition to this class of instrument.

Locating Gear Centers

By J. H. Johnson

With reference to this subject, recently I came across a case the solution of which was difficult.

As will be followed from the sketch, *A*, *B* and *C* represent gears known in all respects and the distances between their centers are known, i.e., *A B*, *B C*

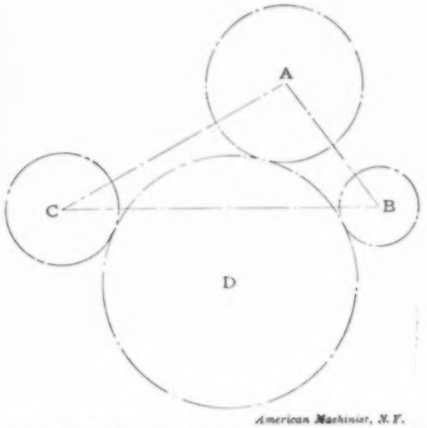


DIAGRAM ILLUSTRATING A PROBLEM IN GEARS

and *C A*. The problem is to correctly locate in all respects the center of *D*, a wheel gearing with the three known gears. A general formula to suit *any case* is required. The number of teeth in *A*, *B* and *C* are not equal.

This problem occurred in practice, and as no formula was forthcoming from a large force of draftsmen and designers, the chart was drawn out several times full size, and after careful measurement the sizes thus obtained were checked through the triangles, a long process.

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

A Brazing Job

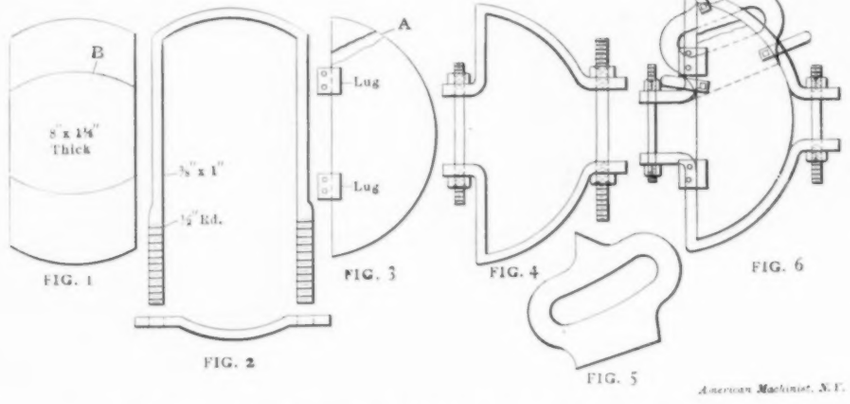
The repairing of broken castings has become so common it does not now excite much attention, but I recently had a job that caused me some worriment and a wish that all the iron ore ever dug, had been turned into wrought iron or steel, instead of into gray iron.

The job consisted of brazing the inner head of a tandem compound 250-horse-power Buckeye engine, which had been broken by starting up without draining the cylinder properly. The two broken pieces are shown in the line cut in Figs. 1 and 3, the break occurring on the lines *A* and *B*. Fig. 1 was a nice clean break and very easily clamped and brazed, but the clamping played an important part. The form of clamp used on this piece is shown in Fig. 2.

As the piece shown by Fig. 3 was broken in such a way as to slide when clamped together I found it difficult to hold, as the end would get out of line from the expansion of the clamp. In fact I brazed the piece twice and had to break it apart both times as it was from ¼ to ⅜ of an inch out of true. The clamps for this piece were made as shown in Fig. 4. After this I cut a slot out of a plate, ⅜ inch thick, that was 2½ inches wide and 7 inches long, so the heat would be directly on the part of the casting to be brazed. Fig. 5 shows the plate and Fig. 6 shows it in place, with the clamp also on the casting.

The forge was then prepared by arranging firebrick so they leave an opening that was 3½ inches wide, with the ends entirely open to feed in the coke. This fuel being all we had to use, it was carefully selected and crushed, thus making it a good heating medium. The clamping shown finally made it possible to braze the piece without its slipping.

I have found in doing this kind of work that it is time saved to take no chances as to clamping and if I had resorted to the plate after the first failure, I would have saved myself a lot of worry and about two hours' time in the completion of the work. As it was, the job was done in ten hours and the engine is now doing business at the old stand as usual.



BRAZING CAST IRON INNER HEAD OF BUCKEYE COMPOUND ENGINE

The Swiss preparations "castolin" and "castolot" spelter were used for both pieces and certainly filled the bill, for in breaking the piece, shown by Fig. 2, apart at a black red heat it did not break in the braze but in both instances close beside it and at about the same angle.

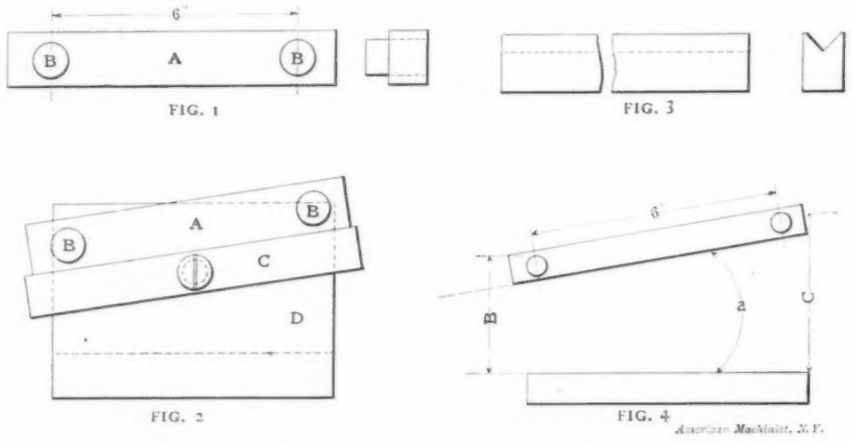
St. Louis, Mo. T. THOMS.

A Parallel for Measuring Angles

The accompanying sketches show a method of laying out and measuring angles which I have found to give very accurate results, especially on the surface grinder and milling machine and in the inspection of jigs, fixtures, etc.

In Fig. 1, *A* is a hardened and ground parallel 7 inches long, 1 inch wide and ½ inch thick, with two plugs *B B*, located one at each end with centers exactly 6 inches apart.

Suppose we wish to fasten the parallel *C*, Fig. 2, to the angle iron *D* so that *C* will be at an angle of 10 degrees with the base of the angle iron. We will place the measuring parallel *A* on top of the parallel *C* clamping it lightly. Taking the sine of the angle of 10 degrees which is 0.17365 we multiply it by 6 (the distance between *B B*, Fig. 1), this gives us 1.0419 which is the amount that one of the plugs *B*, Fig. 2, must be above the other plug in order to have the parallel *C* at an angle of 10 degrees.



A PARALLEL FOR MEASURING ANGLES

By setting the angle iron on a surface plate or the bed of a machine and using a Brown & Sharpe hight gage or some good indicator, the parallel can be very easily set to the desired angle.

Fig. 3 shows a parallel of the same size, with a 90-degree slot running the whole length of one side, which can be used in connection with parallel *A* in measuring taper plugs, etc.

For the benefit of the young mechanic who may not clearly understand the above, I will suggest the following formula in connection with Fig. 4:

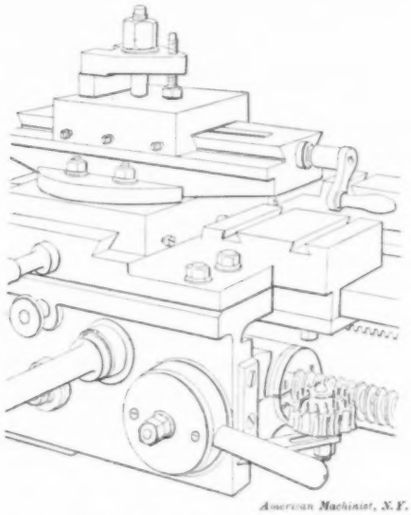
A = Angle,

$C = B +$ (sine of angle $a \times 6$).

Worcester, Mass. H. A. MANN.

Indicator for Screw Cutting

Many lathe hands content themselves with chalk marks on slide, face plate and lead screw, in order to tell where the cut is to be entered. Several lathes have devices built in the carriage to enable the place to be found rapidly and accurately, but the one here shown can be attached to any lathe carriage. It is driven by the



INDICATOR FOR CATCHING THREADS

lead screw and is supplied with small pegs as markers. It will do the work effectually for any kind of thread, whether regular or irregular, on any lathe; and is easily applied and removed. It is made by Werkzeugmaschinen-Aktiengesellschaft, Cologne, Germany.

ROBERT GRIMSHAW.

Dresden, Germany.

Coil Friction Clutches

Friction clutches are now in use, which will transmit 1000, and even more, horsepower. A type of clutch which is satisfactory for the transmission of large powers is the coil friction clutch. The figure shows the essential parts of such a clutch without the mechanism for throwing it into or out of action. It consists of a steel coil wound on a chilled cast-iron drum. At each end of the coil a head is formed. The head at the large end is attached to the pulley or shaft that is to be set in motion, while that at the smaller end of the coil serves as a point of application of a force, which produces an initial pull on the coil to wind it on the drum, thus gripping it firmly. The motion of the drum is thus transmitted to whatever is attached to the large end of the coil.

The friction of the coil on the drum is the same as that of a rope or belt on a pulley. That is, the relation of tension at the small end of the coil to that at the large end may be found from the equation

$$\frac{P}{Q} = e^{\mu\alpha},$$

where

P = Pull at large end of coil;
Q = Pull at small end of coil;
e = Base of natural logarithms = 2.718;
μ = Coefficient of friction between coils and drum;

and

α = Angle subtended by coil in radian measure,
= 6.283 for each turn of coil.

The table gives values of $\frac{P}{Q}$ for various values of α on the assumption that μ for steel on cast iron, lubricated, is 0.05.

α	$\frac{P}{Q}$	α	$\frac{P}{Q}$
1 turn.	1.37	5 turns.	4.81
2 turns.	1.87	6 turns.	6.58
3 turns.	2.57	7 turns.	8.60
4 turns.	3.51	8 turns.	12.33

If D is the diameter of the drum in inches, and N the number of revolutions per minute, then

$$Horsepower = \frac{\pi D N P}{33{,}000 \times 12} = 0.00000793\, D N P.$$

As an example let it be required to find the horsepower capable of being transmitted by a clutch in which a coil of six turns is wound upon a drum 24 inches in diameter. The shaft makes 200 revolutions per minute and a pull of

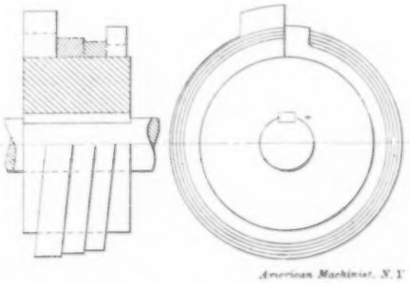


DIAGRAM OF A COIL FRICTION CLUTCH

500 pounds is applied at the small end of the coil.

From the table we find

$$P = 6.58\ Q = 6.58 \times 500 = 3290 \text{ pounds};$$

and

$$Horsepower = 0.00000793 \times 24 \times 200 \times 3290 = 125.$$

One of the drawbacks of this type of clutch is the fact that it will transmit motion in one direction only.

Chicago, Ill. H. L. NACHMAN.

Finding the Area of a Flanged Spherical Segment Drawn from Sheet Stock

The sketch, Fig. 1, shows a segment of a sphere drawn from 25 gage O. H. black plate steel. There is a 1¼-inch flange all the way round. How can the area of this piece and the size of the blank from

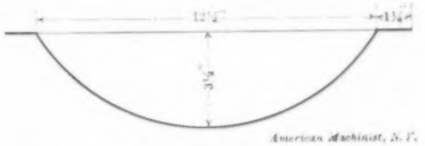


FIG. 1. THE PIECE TO BE DRAWN UP

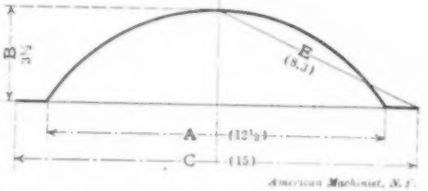


FIG. 2. FINDING THE AREA OF THE WORK

which it is drawn be computed? Also how much does the metal stretch per foot of diameter? SUBSCRIBER.

In reply to the above inquiry E. W. Zeh writes as follows:

The area of the segment of a sphere with a flange, if the diameter A and the depth B, Fig. 2, are given is computed by ascertaining first the area of the segment of the sphere proper to which the area of the ring or flange has to be added.

The area of the segment of the sphere is found according to the formula

$$S = \frac{\pi}{4}(C^2 + 4h^2).$$

The area of the ring or flange is found by deducting the area of the inner diameter A from the area of the outer diameter C.

In the case given the area of the segment of the sphere is 0.7854 (12.5 × 12.5 × 4 × 3.5 × 3.5) = 161.20 to which the area of the flange or ring, 54, has to be added.

The total area is, therefore, 215.20.

The blank from which the article is to be produced must have the same area or 215.20 square inches. A blank of 16.6 inches diameter corresponds therewith.

In practice—provided the flange is not too wide—a sufficiently accurate result will be obtained by taking the chord E as the radius of the blank.

If the material is allowed to follow its own bent, it will not stretch at all but rather contract as through the decrease of the diameter from the blank to that of the drawn article a thickening of the material takes place.

Newark, N. J. E. W. ZEH.

An Automatic Drilling Machine for Electric Cable Sockets

Figs. 1 and 2 show a brass casting for an electric-cable socket, of which we had very large quantities to make. The first operation was to drill and face the hole *A*, and boss *B*. This was done in an upright drill press. Then came the remaining operation of drilling the deep hole *C* for the cable end to fit in. Figs. 3 to 8 show a machine and details for drilling this hole automatically; all the operator is called upon to perform is to supply castings, clamp them in position, and take them out when completed. One boy operator can keep two machines going to their full capacity if on fairly large work, and the output of sockets per day is very large.

Referring to Fig. 3, *D* is an ordinary turret-lathe bed, and E the turret, which is of much larger diameter than usual, and does not come up as high as the center

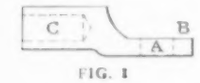


FIG. 1

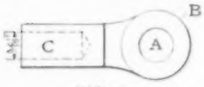


FIG. 2

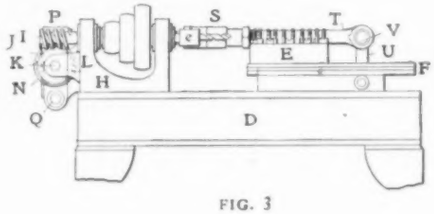


FIG. 3

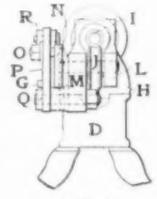


FIG. 4

FIG. 6

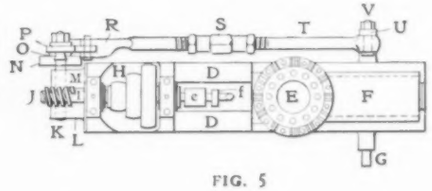


FIG. 5

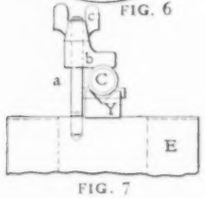


FIG. 7

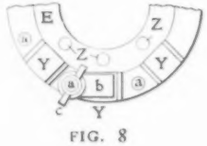


FIG. 8

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AUTOMATIC MACHINE FOR DRILLING CABLE SOCKETS

of the drill spindle. *F* is the turret slide, and *G* the shaft which carries the pinion for operating the turret by engaging with a rack fixed on the bottom, exactly the same as a turret lathe. *H* is a headstock carrying a 3-cone pulley on the drilling spindle, on the back end of which is a worm *I*, which drives a worm wheel *J* carried by the shaft *K* fitted in the two brackets *L* and *M*. On the end of the shaft *K* is keyed the gray-iron face plate *N*, with a dovetail slot planed across the center, as shown in Fig. 5. This is for adjusting the working stroke of the drill by the crank pin *O*, on which is a square block, which slides in a slot machined in the link *P*. This arrangement is exactly like the Whitworth quick return, formerly fitted to shaping machines, and in this case gives a quick return to the backward stroke of the turret which carries the work. The link *P* is pivoted at the bottom end on the pin *Q*. *R* is a tubular connecting rod with a knuckle joint at one end which couples up to *P* by the pin shown. On the opposite end is cut a left-hand thread which screws into the coupling socket *S*, and lock nut shown on the end. *T* is a coupling rod, which connects up the lever *U*, keyed on the shaft *G*, which carries the pinion by the pin *V*.

Thus the coupling socket *S* can shorten or lengthen the distance between the capstan and the drill as may be required, by having a right- and left-hand thread cut in each end as shown.

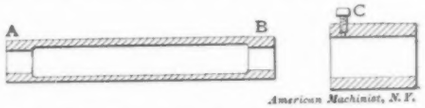
Fig. 6 shows the bottom of the turret, or work carrier in this case. Instead of the usual six tool-holder holes there are 12 fixtures for supporting the work on the top, as shown in Figs. 3 and 4, while Fig. 8 shows an enlarged view of the top of the turret. Twelve hardened-steel plunger bushes *W* are required at the bottom, to locate the turret. *X* shows the hardened-steel star or indexing ratchet which takes the place of the usual one having six divisions only. Fig. 7 shows the method of securing the work in position, in elevation, and Fig. 8 shows the plan. The steel V-blocks *Y* are fitted in 12 equidistant slots milled across the top and ⅛ inch deep, and secured by a central filister-head screw. On the inside of the blocks are the locating studs *Z*, which are screwed into the turret and fit into the hole *A* in the sockets. These studs determine the position of the work, take all the end thrust when drilling and also prevent the work from turning round. A long stud *A* is screwed into the turret onto which the small clamp *b* fits, this being drilled a nice sliding fit. The wing nut *C* finally secures the work in position, while it is being operated upon, although very little pressure is required here, as the locating stud *Z* practically does the work. The chuck for gripping the drill is shown at *e*, and *f*, in Fig. 5, shows a flat drill with a facing wing on, for facing the ends of the sockets if required.

In action the machine is very similar to a turret lathe, the connecting rod giving the capstan its stroke instead of an operator, while the link *P* gives it a quick return, saving time on the idle stroke.

London, England. MAGNET.

Grinding Sleeves Internally

Sometimes we have to grind a hole at one or both ends of a number of sleeves or tubes, and find that, though the length to be ground is small, the time taken in chucking each tube makes the job a costly one. Suppose we have some sleeves which are 12 inches long, 2 inches outside diameter and have an inch hole at each end 1½ inches in length, the remainder of the sleeve being enlarged, as in the sketch at *A B*. The sleeves have been rough turned and bored leaving 1/32 inch inside and outside for grinding. The ends of the sleeves are dipped in the lead pot and hardened. The outside is then ground down to finished size, and the holes have to be ground out to a 1-inch plug.



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SLEEVE TO BE GROUND AND ITS HOLDER

Make a cast-iron bush 3½ inches diameter, 6 inches long, with a 2-inch reamed hole. Drill a ⅜-inch tapping hole 1 inch from one end; tap and fit a screw and small brass pad as at *C*. Fix the bush in the chuck of the grinding machine, put a 2-inch test bar in the hole of the bush, tighten *C*, and set the bush until the test bar runs true for 6 or 8 inches from the chuck. Slack off *C*, take out the test bar, put end *A* of the sleeve into the bush, tighten *C* and fix a three-point steady at *B*. Grind hole *B*, then open the steady, slacken *C*, take out the work, reverse the ends putting *B* into the bush and grind *A*.

After once setting the cast-iron bush any number of tubes may be ground for the cost of actual grinding, discarding setting time altogether. There are many jobs where this idea is a great time-saver, and the cast-iron bushes as a rule pay for themselves if there are half a dozen sleeves to grind.

Any slight variation in the outside diameter of the sleeve can be neglected so long as the bush will hold the largest one. The end of the sleeve in the bush may run out two or three thousandths without materially affecting the truth of the end in the steady rest.

Birmingham. U. S. GARDE.

Indexing Fixture and Die for Piercing Brass Stencils

The accompanying drawing shows an indexing fixture and die used in piercing the border of a brass stencil for barrel heads. There were only a few hundred of these stencils to be made, and it was advisable, consequently, to devise as cheap a fixture as possible consistent with efficiency. The device shown was not only cheap, but it did the required work quickly and accurately.

In Fig. 1 is shown a portion of the stencil and the border to be cut, and also one of the gaging holes previously pierced for the gage pins F and F', Fig. 2. Referring to Fig. 2, A is the die, B the shoe and base of the fixture, and C the indexing disk. The disk C was made of as large diameter as possible, for the purpose of insuring accuracy and also for the better support of the work.

The position of the fixture with relation to the press, as well as the method of operation, is, of course, easily understood from the illustration. The operator, after each stroke of the press, disengages the spring pin D from the locating hole by means of the lever E and revolves the disk to the next hole which the pin immediately snaps into.

Rochester, N. Y. W. R. H.

A Pin Problem

Tom and I opened up a small job shop about a year ago. Tom is manager and I am the chief and only draftsman when other matters do not demand my attention. We each of us have served an apprenticeship in the shop and have tried to acquire a theoretical knowledge of our business by night study in a correspondence school, and this has usually been sufficient to see us safely through the difficulties of new and unfamiliar work.

One day last week, Tom came in with a job he had taken, in which it was necessary to calculate the strengths of some of the parts. At one part of the machine a weight of 50 pounds is dropped a distance of 1 inch and strikes an overhung pin 1⅛ inches from its point of support.

The design of this pin bothered us a little, as we both knew something of the great increase in stress caused by shocks as compared with a simple dead load, and we wanted to be well on the safe side. Our textbooks seemed to throw very little light on the matter, but after some thought we hammered out the following solution:

Let $W =$ the weight dropped on the pin, $h =$ the distance the weight drops, $D =$ the maximum deflection of the pin, $P =$ the load on the pin corresponding to this deflection, $d =$ the diameter of the pin, $I =$ the moment of inertia of the pin section, $E =$ the modulus of elasticity, $f =$ the maximum fiber stress, and $l =$ the length of the overhung pin to the point of application of the load.

In falling the weight will do work equal to Wh. This work must be equal to that done in deflecting the pin if the weight is stopped. Since the deflection is proportional to the load causing the deflection the average value of the load is $\frac{1}{2} P$ and the work will be equal to $\frac{D P}{2}$.

Equating the values

$$W h = \frac{D P}{2}. \qquad (1)$$

Now the deflection of a cantilever loaded at the end by P is

$$D = \frac{P l^3}{3 E I}.$$

Substituting this in the first equation we get

$$W h = \frac{P^2 l^3}{6 E I}. \qquad (2)$$

We also know that the bending moment

$$P l = \frac{d^3}{10} f$$

and

$$I = 0.05\, d^4.$$

Substituting these values in (2), we get

$$W h = \frac{d^6 f^2 l}{600 E\, 0.05\, d^4} = \frac{d^2 f^2 l}{30 E},$$

or

$$d^2 = \frac{30 W h E}{f^2 l}.$$

Applying this to the conditions as originally stated and taking $f = 10{,}000$, and $E = 30{,}000{,}000$ we find that

$$d^2 = \frac{30 \times 50 \times 1 \times 30{,}000{,}000}{100{,}000{,}000 \times 1.125} =$$

$$\frac{450}{1.125} = 400$$

and

$$d = 20.$$

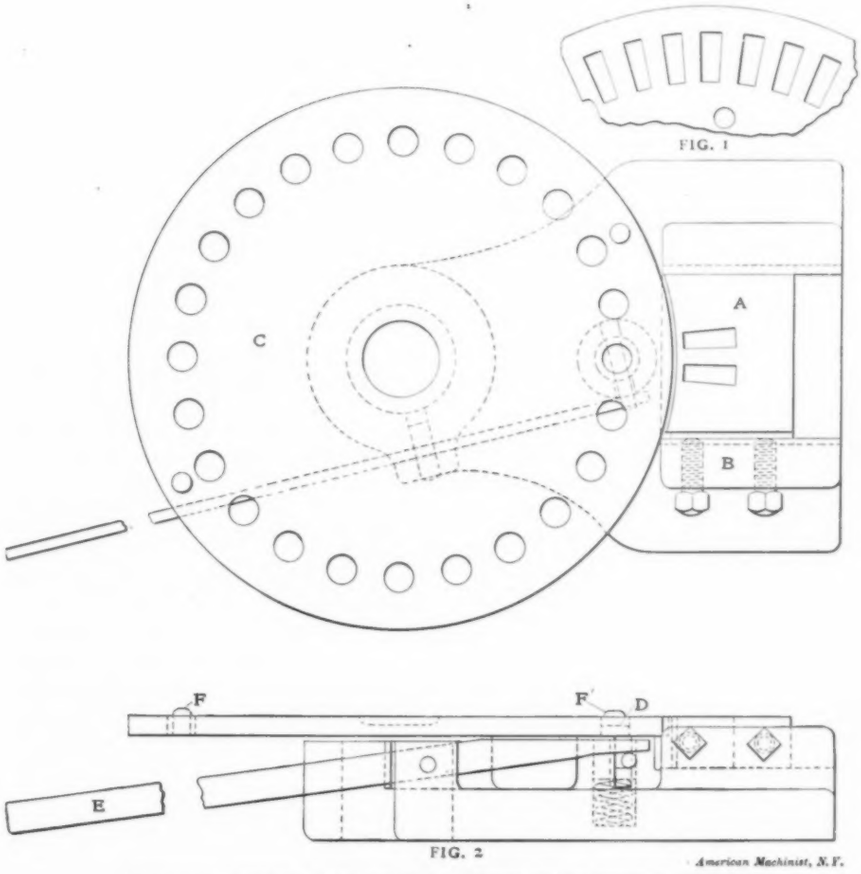
The result naturally staggered us and we carefully went over the figures and derivation several times, but failed to detect any flaw. Now, while we wanted to be on the safe side we did not care to use a pin which would be bigger than all the rest of the machine put together.

"Look here, Bill," said Tom, "if we were to reduce the length of the pin to zero that fool formula says that the diameter should be infinite and if we make the length infinite the diameter should be zero."

We looked blankly at each other and again at the paper, but could see no sense in it. So we concluded to put it up to the AMERICAN MACHINIST.

Now, Mr. Editor, where is the trouble? Can you or any of your readers locate it? If so you will confer a lasting favor on

Indianapolis, Ind. BILL.



INDEXING FIXTURE AND DIE FOR PIERCING BRASS STENCIL BORDER

Cutting Keyways on the Die Sinker

The accompanying drawing shows the way in which a die sinker may be equipped for cutting keyways in piston rods and valve stems and drift holes in drill and milling-machine sockets.

Every machinist knows that it is quite a job to drill, chip and file a keyway in a piston rod or a valve stem. A device of this kind has proved itself to be just the thing for such work and it can be made in any "one horse" shop with very little cost.

Fig. 1 shows the device and the way in which the work is clamped. Fig. 2 shows the way the device is attached to the machine. Stand *A* is machined and a dovetail is cut across its bottom to fit the dovetail of the machine knee. Slide *B* is machined to fit the top of *A*, and slotted crank disk *C* is attached to shaft *D*. A T-slot is cut halfway across the face of the disk *C* to receive an adjustable crank pin which gives the slide *B* the stroke required for the keyways. Bracket *E* is attached to the side of the die sinker to receive a short shaft, one end of which carries pulley *F* while the other end is connected to the slide reciprocating device. Belt *G* passes over the driving shaft of the die sinker and around the pulley *F* which drives the work to and fro while the keyway is being cut. The machine spindle is run at the required speed and while the work is moving back and forth under the cut, it is fed up into the cutter by means of the elevating screw of the die sinker.

Fig. 3 shows the universal coupling and the disk with the T-slot cut across its face which operates the work slide of the machine. This device is now used in the shop where I work and is doing very satisfactory work.

Washington, D. C. H. D. CHAPMAN.

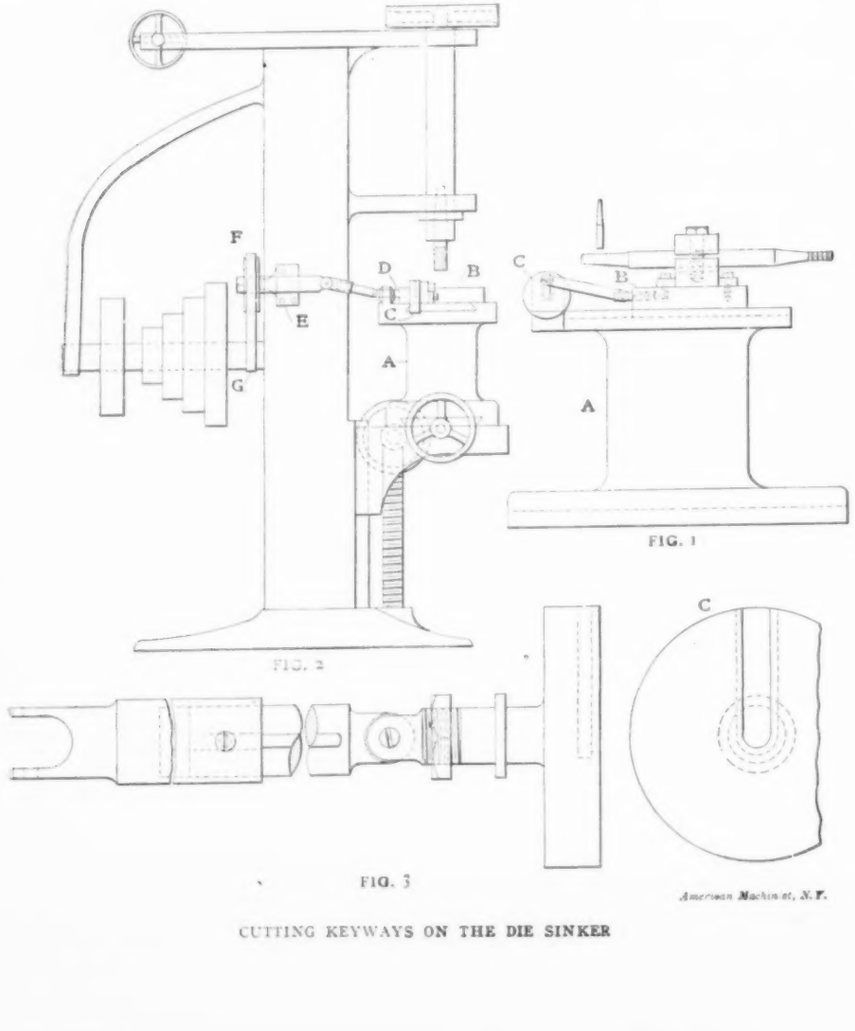


FIG. 1

FIG. 2

FIG. 3

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CUTTING KEYWAYS ON THE DIE SINKER

A Good Taper Attachment

At the Artisan school, where we have a chance to do things, we have changed an ordinary taper attachment to a good one.

As made, it had a guide, as shown in Fig. 1, two feet long, and a sliding block six or seven inches long, with taper gib and end screws to take up the wear.

It was so located as to catch chips and grit; and the short sliding block just right to wear itself and the guide loose in the middle; with taper gib to take up lost motion in the middle, and be too tight to slide at the ends.

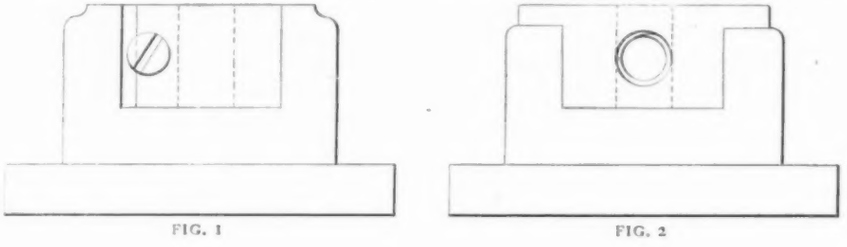

FIG. 1

FIG. 2

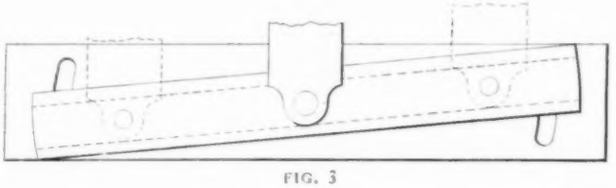

FIG. 3

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TAPER ATTACHMENT

Fig. 2 shows that ¼ inch was planed from the top of the guide, and the slide made with a covering ledge, which effectually prevents chips and dirt from getting to the wearing surfaces.

The sliding bar is the same length as the guide; is a mechanical fit; has no take-up gib, but has three holes to attach the cross-slide bar; one in the middle, and one near each end as shown in Fig. 3. So while it would generally be used in the middle hole when set at a steep taper and the long slide might hit the bed at one end, the attachment can be made at one end. Hence there is nothing that the old plan would do, that the new one will not.

The long slide cannot be much, if any, more costly than the old, including the wedge and screws; and the job is done for all time.

The holes in the slide are stopped with headless screws, and when one is out, a hole in the end of the slide is tapped to put it in; and when the bolt to connect the slide is out, a hole is drilled in the other end of the slide so the bolt will go in its whole length, except about two threads, where a couple of turns makes it secure.

It seems to me that the difference between the old and the new arrangement is just the difference between right and wrong.

Syracuse, N. Y. JOHN E. SWEET.

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Balancing a Rock Crusher

This problem, completely solved by a graphic method, appeared in the AMERICAN MACHINIST, Volume 31, Part 2, page 765. It should be stated at the outset that it was the clearness of the original article which prompted the careful study of the problem, and the result of that study is here presented.

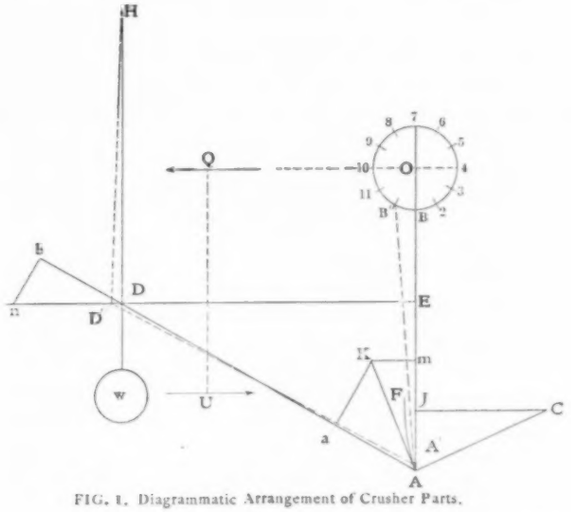


FIG. 1. Diagrammatic Arrangement of Crusher Parts.

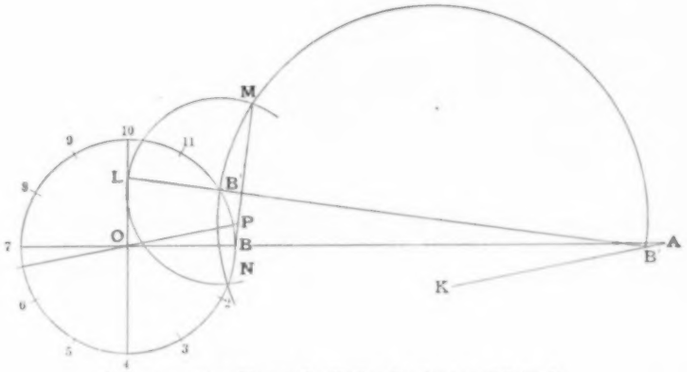


FIG. 2 a. Klein Diagram for Finding Acceleration of Point A. Very much Distorted.

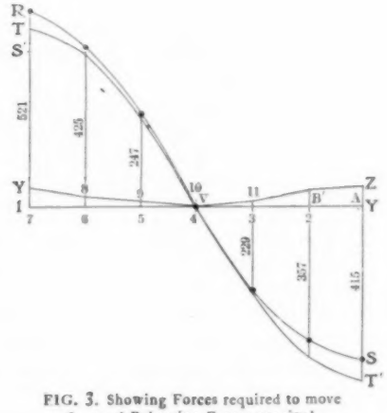


FIG. 3. Showing Forces required to move Jaw and Balancing Forces required.

FIG. 2 b. Showing Acceleration of Point A. Actual Values obtained when all Parts were Laid off Full Size.

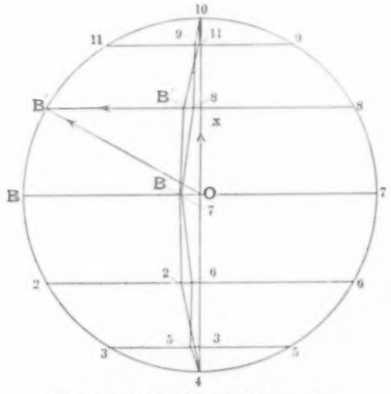


FIG. 4. Showing Lack of Balance after Weights are supplied to Fly-wheel.

American Machinist, N.Y.

Fig. 1 shows diagrammatically the arrangement of parts of a crusher, although very much distorted. Let BB' represent the path of the eccentric, AB the pitman articulated at A to the two links AC and AD. Link AC abuts against the frame at C, and the point D is constrained to move about H as a center, or practically in the direction ED. As the eccentric revolves the point D (a part of the jaw HDE) has a small motion which crushes the rock against the frame. In the actual crusher under consideration the eccentric OB is ½ inch, AB 37 inches, AC 13 inches, AD 23 inches, JA 3½ inches, JE 3 inches, and DH 37 inches.

In the original article the method of solution was briefly as follows: An enlarged displacement curve for the point D was plotted and from this curve tangents were drawn at various points, and from values depending upon these tangents a curve was plotted showing the velocity of the point D for all positions of the eccentric. From the velocity curve tangents were drawn, and from values depending upon these tangents a new curve was plotted showing the acceleration of the point D for all positions of the eccentric when moving at a uniform, specified velocity. From the accelerations obtained in this way the counterbalance weight was calculated.

Anyone who has ever undertaken to accurately draw tangents to an irregular curve knows how very difficult it is. Even with the most accurate work values of the acceleration obtained by the above method would be liable to an error of at least 5 per cent., and probably more. The following method is believed to be correct, with the exception of a few values too small to be considered in any graphic solution and too small to affect the final result by an appreciable quantity.

The method here used may be briefly outlined as follows: The eccentric OB is assumed to revolve uniformly at 60 revolutions per minute. From this as a starting point find the acceleration of the point A, and from this find the acceleration of the point D. A curve showing all

the values of the acceleration of the point D is necessary for two reasons, and only two. First, to establish the fact that the unbalanced forces, to which the accelerations of the point D are directly proportional, follow the same law as the horizontal components of the centrifugal force of a weight in a revolving flywheel. Such forces are represented by a sine curve. Second, to find the value of the force exerted by the jaw $D\,H$ at the ends of its stroke. Assuming that the point D travels in a straight, horizontal line, the force exerted by the jaw will evidently be entirely in a horizontal plane.

The acceleration of the point A was obtained by a Klein diagram, a brief description of which is here given. In Fig. 2a, $B\,B'$ represents the eccentric circle, $A\,B$ the pitman, and $A\,K$ the path of the point A, which should be determined for each position of the eccentric considered. This is easily done by drawing a perpendicular to the line corresponding to $A\,C$ for any position of the eccentric $O\,B$, Fig. 1. Lay off the values $O\,B$ and $A\,B$ to any convenient scale, using, of course, the same scale for each. Divide the eccentric circle into any convenient number of equal parts, as the points B, B', 1, 2, 3, etc. With $A\,B$ as a radius and the points B, B', 1, 2, etc., as centers, swing arcs cutting the line $A\,K$. Let us consider the point B'. Through B' on the eccentric circle and B' on the line $A\,K$ draw a straight line, and produce it to the point L. On $B'\,B'$ as a diameter draw a partial circumference $N\,B'\,M\,B'$. With the point B' on the eccentric circle as a center and $B'\,L$ as a radius, draw a partial circumference $N\,L\,M$. Join the points M and N with a straight line, and through O draw a line $O\,P$ parallel to $A\,K$. The distance $O\,P$ is then directly proportional to the acceleration of the point A when the eccentric is in the position B', and if the proper scale has been chosen at first it is equal to the acceleration. Plotting the $O\,P$ distances, which correspond to the points 2, 3, 4, etc., of the eccentric, perpendicular to the line $A\,K$ (Fig. 2b) we obtain the curve $e\,f$. The values given in Fig. 2b are the actual values obtained when the Klein diagram was plotted full size. Klein's diagram is both theoretically and practically correct. For the theory of it, which is quite complicated, see the *Journal* of the Franklin Institute for September and October, 1891.

We now have quantities which are directly proportional to the acceleration of the point A, and wish to determine what the absolute values are. If we determine the absolute value for any particular position of the eccentric the scale of the curve $e\,f$ is at once established, and the value of the acceleration of the point A for any position of the eccentric may be found. Let us consider the eccentric to be in the position B. The point A is then at its lowest position. At that instant the radial accelerations of the points A and B are precisely the same. That is, the point A is moving in harmonic motion at that instant. It is well known that the radial acceleration of a point on a revolving circumference is equal to the square of the lineal velocity of the point divided by the radius. In this case the lineal velocity is 3.1416 inches per second, and the radius is ½ inch. Therefore, the radial acceleration is equal to 9.86 divided by ½, which equals 19.7192 inches per second per second, or 1.643 feet per second per second.

In Fig. 1, lay off $A\,m$ to any convenient scale, from A to represent 1.64. Draw $m\,K$ perpendicular to $A\,m$, intersecting $A\,K$ at K. We then have $A\,K$ representing the acceleration of the point A in both direction and magnitude. With proportional dividers set one end equal to the distance $7\,e$ in Fig. 2b, the other end equal to the distance $A\,K$ in Fig. 1. Then by setting one end of the proportional dividers to any of the values in Fig. 2b and laying off the distance on the other end along $A\,K$ in Fig. 1, we have the absolute acceleration of the point A in direction and magnitude, to the same scale as the 1.64 was laid off on $A\,m$. It must be remembered that both A and K will have new positions for each eccentric position.

Draw $K\,a$ perpendicular to $A\,D$. With dividers lay off the distance $D\,b$ (Fig. 1) equal $A\,a$. Draw $b\,n$ perpendicular to $A\,D\,b$. Then $D\,n$ represents, to the same scale as before, the acceleration of the point D. Plotting the $D\,n$ distances perpendicular to $l\,r$, Fig. 3, we obtain the curve $R\,V\,S$, the ordinates of which represent the accelerations of the point D, and are, therefore, proportional to the forces exerted by the swinging jaw $D\,H$.

Lay off $7\,S'$ equal to $A\,s$ (Fig. 3), and take T midway between R and S'. If the flywheel is balanced so that the balance weight exerts equal and opposite force to that represented by $7\,T$, it is easy to see that the balancing force will be just as much too small at the beginning of the stroke, as it will be too great at the end of the stroke. Therefore, $T\,V\,T'$ is plotted as a sine curve. Such a curve represents the horizontal components of centrifugal force of a weight revolving in a wheel, which are the forces we wish to supply. By scaling the distance $7\,R$ (which would equal $D\,n$, in Fig. 1, if the latter were not distorted) it is found to represent an acceleration of 0.875 feet per second per second. In the original article the weight of the jaw was stated to be eight tons, and to have a radius of gyration of 44 inches, as indicated at w in Fig. 1. Then the acceleration at the radius of gyration will be 19 per cent. more than at the point D. Taking 119 per cent. of 0.875, we have 1.04 feet per second per second for the acceleration at the radius of gyration. By applying the well known law of force that *force equals mass times acceleration* we have: force required to give the jaw its maximum acceleration equal to $1.04 \times 16{,}000$ divided by 32.2, which equals 521 pounds.

In the original article it was stated that there was a convenient place in the flywheels (which are on the same shaft as the eccentric) for counter-balance weights two feet from the center of the shaft. The force $7\,T$ (Fig. 3) scales 470 pounds to the same scale as $7\,R$ scales 521 pounds. This is the maximum force to be exerted by the balance weight. The centrifugal force of a revolving weight is

$$\frac{W\,v^2}{32.2\,r},$$

where W is the weight in pounds, v the lineal velocity in feet per second, and r the radius in feet. We have, therefore,

$$\frac{W \times 157.8}{2 \times 32.2} = 470,$$

from which W is found to be 191.8 pounds, an amount 2.1 per cent. less than that found by the tangent method of the original article.

The curve $Y\,V\,Z$, of Fig. 3, is plotted from the distances measured on the ordinates between the curves $R\,V\,S$ and $T\,V\,T'$. It shows the lack of balance. It also shows that it is impossible to make the balance perfect by the use of unbalanced flywheels, no matter what the phase may be. This conclusion is substantiated by the vibration diagrams given in the original article. These diagrams were obtained from an actual crusher under operation after the flywheel had been weighted. If it were possible to completely balance the machine by means of another weighted wheel running at twice the speed of the eccentric, as was claimed in the original article, the vibration diagrams must necessarily have been in the general shape of a figure eight, which they were not.

In Fig. 4, consider B' as a weight revolving about O as a center. Such a weight would tend to pull away from the center, and would, therefore, exert force in the direction of the arrow on $O\,B'$. If the line $O\,B'$ be taken to represent this centrifugal force in both direction and magnitude, then the lines $O\,X$ and $X\,B'$ will represent the vertical and horizontal components of the force $O\,B'$. Since the vibration of the jaw exerts force in a horizontal direction only, we must balance it with horizontal forces. Therefore, we are interested only in such forces as $X\,B'$, and not in the vertical forces $O\,X$. If the radius of the circle in Fig. 4 be chosen to represent the maximum centrifugal force exerted by the balance weight, and the circle be divided into equal parts to correspond to the positions B, 2, 3, etc., of the eccentric, then it is evident that horizontal lines drawn through these points to a vertical diameter will represent the horizontal components of force exerted by the balance weight. It should be noticed

that the points in Fig. 4 are shifted 90 degrees from the corresponding points in Fig. 1. Then laying off the force represented by the curve *R V S*, in Fig. 3, on the horizontal lines of Fig. 4, we get the curve 9, 10, 11, etc. If the balance were perfect this curve would have no area, and would follow the vertical diameter. It appears from this diagram that this lack of balance could be remedied by adding to or subtracting from the balance weight, but a careful study of the problem will show that the balance is as perfect as may be when flywheel balancing is used.

So far we have left out of consideration one rather important factor. We say that the machine will be balanced when we put a weight of 191.8 pounds in the flywheel, in such a position that its horizontal motion is always directly opposite to the motion of the jaw. But this is not strictly true. When the jaw starts to move in the direction indicated by the arrow at *U* (Fig. 1) it tends to move everything connected to it in the opposite direction. This causes a great force to be exerted in a horizontal plane through the radius of gyration of the jaw, as indicated by the circle *w*. This is the force we wish to balance, and, evidently any force which accomplishes this should act in the same plane. The forces we have supplied by the balance weight are very nearly equal in magnitude to the forces exerted by the jaw, and opposite in direction. They do not, however, act in the same plane, but in a horizontal plane through the eccentric shaft. This gives rise to a couple of considerable magnitude which tends to overturn the machine. This couple acts clockwise for half a revolution and counterclockwise for the other half revolution. The distance *Q U* is 31.5 inches, and the maximum forces acting at *Q* and *U* are (approximately) 470 pounds at each point. Then we have for the overturning moment 470×31.5 divided by 12, equal 1234 pound-foot units. In the design of such a machine the point *D* should be located as near as possible to the lower extremity of the radius of gyration, and the center of the eccentric shaft should be placed as nearly as possible to a horizontal plane through the same point.

The sum of the vertical components of centrifugal force exerted by the balance weight is exactly the same as the sum of the horizontal components. These forces, being vertical, are easily taken care of by the foundation of the machine or by the walls and upright members of the building in which it is placed.

In conclusion, the writer wishes to state that this article is not intended as a criticism on the previous one, and that it was the clearness of the original article that prompted the writing of this one. This is simply a more accurate solution of the problem, and a few points are brought out that were not touched on in the previous article.

Terre Haute, Ind. C. W. SPROULL.

Cutting Chasers in the Lathe

A modification of the method of cutting racks in the lathe on page 231 might be used to cut thread-chasers in the lathe, when a hob was not at hand. The slots in the carrying bar should be milled the size and shape of the chaser blanks and deep enough to allow them to come flush with the surface of the bar. A standard thread of the desired pitch could then be cut on the lathe through both the bar and the chaser blanks. When a number of chasers are required, they could all be cut at once in a short time by this method. The bar should be truly centered and the slots all milled to the same depth.

Wilkes Barre, Penn. F. A. STRAUSS.

Cutting a Thread on a Long Pipe

The article on the above subject on page 187 reminds me of a similar job done in a different way. It was found necessary to cut 13 inches off an 8-inch vacuum pipe 16 feet 6 inches long. The only tool available was a 24-inch by 8-foot lathe. The pipe was chucked by the end which was required to be cut off, supporting the pipe in a steady rest four feet from the chuck and suitable at the extreme end of the pipe. The pipe was first cut in slightly deeper than the thread was to be, with a parting tool. It was then turned and threaded. The taper was accomplished by starting each cut nearer the chuck. When the thread was completed the pipe was cut off with a parting tool where it was first partially parted. After red-leading the flange was screwed on with a 7-foot bar and was tight when the pipe was ⅛ inch from the face of the flange. One man assisted to put the pipe in the lathe, to screw the flange on and remove the job from the lathe. The job was completed in less than an hour and a half. A 26-inch vacuum has been on this pipe for the past two years.

Comstock, N. Y. H. F. K.

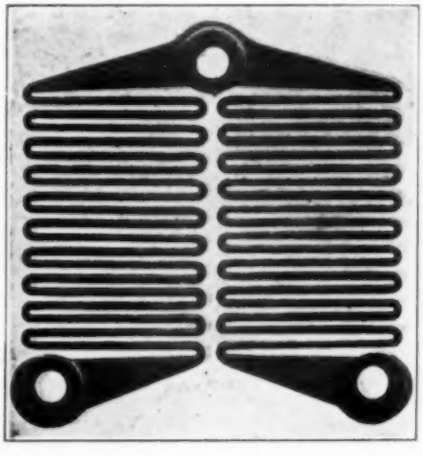


FIG. 1. NATURAL SHAPE OF GRID

Elasticity of Resistance Grids

The two cases of flexible cast-iron grids shown in recent issues of the AMERICAN MACHINIST have been very interesting. The particular shape of a resistance grid makes it naturally very flexible and one of small thickness and considerable length, cast in ordinary iron, can be bent almost double before it snaps. When it does break it will show a very brittle, hard iron.

FIG. 2. TWISTING THAT SHOWS REMARKABLE ELASTICITY

The inclosed pictures to my mind show an iron which has more elasticity than any yet displayed. Fig. 1 is the natural shape of the grid. Figs. 2 and 3 show the twist it will take. From these two pictures the thickness of a metal can be seen, which shows a real flexure of the cast iron rather than the bending of a very thin strip of material.

This cast iron is that used by a large electrical manufacturer for their resistance grids which are used on moving cars and are hence subjected to severe shocks and continual vibration.

Atlanta, Ga. F. H. NEELEY.

FIG. 3. ANOTHER FORM OF ELASTICITY

Secrecy in Regard to Details

In Mr. Pratt's article at page 239 he says, speaking of my remarks on his test of the rigidity of a planer: "Relative to drawings and detailed dimensions I am unable to give them, and if Entropy has been in the commercial field I think he will appreciate the reason." I do appreciate the reason why Mr. Pratt's hands are tied, but I do not think it is a good reason. I appreciate the tender regard which certain manufacturers have for their products.

I am carrying in my pocket the key to a small room downtown. This room has bars across the windows, and its walls and ceiling are covered with a network of small wires. The door is covered, too, and when it is shut they form part of the circuit through which an electric current runs to the nearest police station. I found out about this one day, or evening. I had been worrying about some of the details of a machine which was being assembled in this room, so I called in after the theater to see how the thing looked. I found that the electric contrivance worked to perfection.

This is an extreme case of secrecy. On the other hand I also have in my possession numerous detailed working drawings of machines with perfect freedom in their use. The AMERICAN MACHINIST publishes details every week which would have been entirely refused a few years ago. What are the influences which lead different men in these different lines? Take the first case: The man for whom I was designing this machine had just sold out a plant for the manufacture of a certain line of goods and was embarking on a new venture in the same line. The old line had made a fortune for its owner. The fortune was made by the use of automatic machinery which was invented by him, supplemented by what little mechanical skill and ingenuity he was able to bring to the work. He sold out because he had struck on a new idea. To develop the new idea he needed absolute secrecy because the purchaser was necessarily wondering why he was willing to sell out and was unscrupulous enough to try to find out. Patents would be of little use because it is impossible to tie up a mechanical device tight enough so that some other man cannot find other mechanical means for accomplishing the same result. In this case there really was no way to accomplish his purpose except through secrecy.

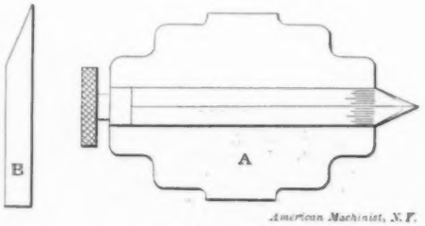
But on the other hand, take the manufacturer of any standard machine. If anyone can go into the market and buy a machine there is no possible use in any concealment. Detailed drawings might just as well be published as to send out the machines. Anyone who buys can direct and copy and test and publish the results. In this connection I remember another firm for which I was working brought out a new engine lathe which was really new, as they had never built that size lathe before. One of the first of the lot was sold to a local dealer and by him sold to a Western manufacturer of lathes who, at that time, did not include that size lathe in his list. Three months later the Westerner brought out a lathe with all the measurements of ours, including the large step of the cone pulley being ¼ inch small to correspond with the other steps, which was a mistake that some way crept into that first lot and was not discovered until after Mr. Westerner bought his machine. I mention this to show that no one can possibly avoid having the details of his machinery known to his competitor if he sells in the open market.

There is another point of view. I talked with two lathe builders a little while ago. Each said that he did not know what kind of an apron the other used on his lathe. Both use aprons so near alike that it would take an expert to tell the difference. Both knew exactly what the other one used unless they were blind. What is the use of telling a prospective customer any such fairy tales? I believe that it is a manufacturer's and a designer's duty to themselves to know what their competitors are doing. There is no need of running down another competitor to make a sale, but it is necessary to know what his strong points are in order to know what to say in support of your own machine. Moreover, anyone who believes you foolish enough to remain ignorant of what your competitor is building will also believe you ignorant of what is modern in your own work.

Springfield, Mass. ENTROPY.

A Graduated Footstock Center for the Miller

At page 146 is shown a gage for setting cutters on center. I also have a scheme which I think has some advantages in this line. You do not have to hunt for the device when you want to use it as it is always in place ready to use and there is nothing about it to get out of order. The idea consists simply in graduating the footstock center in thirty-seconds, sixteenths and eighths as seen in the sketch at *A*. I have used it for a couple of years and find it very convenient in setting cutters for reamers, dies, keyways, etc. It takes only a short time to graduate the center on any machine with the micrometer dials and saves lots of time when setting up work.



GRADUATED FOOTSTOCK CENTER FOR THE MILLER.

The other sketch at *B* shows a straightedge I find very handy to use in conjunction with the graduated center.

S. Boston, Mass. J. F. DALY.

Osborne's Wonder Clock

The "old line" watchmakers call it a gravity clock. Nothing but a piece of plate glass with a stud in the center for the hands to revolve upon.

The hands are made very light, and the disks are hollowed and each fitted with a perfectly fitted watch movement, then carefully balanced. Now two segments of lead are made, one for the minute arbor of the movement in the minute hand, and the other fitted to the hour pipe or cannon of the movement in the hour hand.

When the hands are fitted with large fusee jewels and placed on the stud with the watch movements properly set, the centers of gravity of the two hands are constantly changing as the lead weights revolve. The hands may be held together or whirled around, or taken off and handed around and they will always go back to the correct time when left alone on the stud.

Buffalo, N. Y. E. T. CASLIN.

A Three-tool Boring Head

I note Mr. Viall's criticism on page 236 of my proposed three-tool boring head. He says: "I never had any use for one anyway." Personally I never had any use for a battleship or a flying machine, but I have no doubt they have their uses.

His statement of his experience with three-cutter tools shows no fault in the *tool* itself. A tool should not be condemned for the lack of skill of the operator.

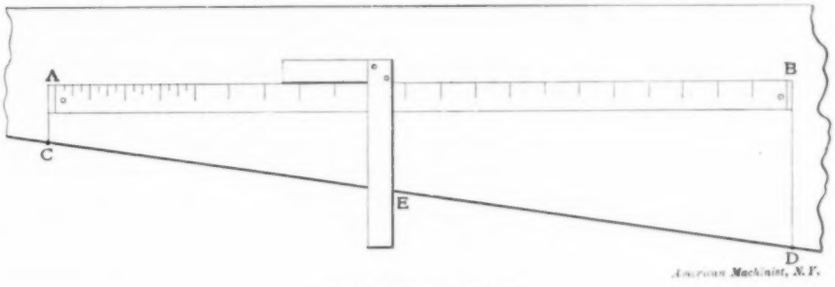
New York. E. A. DIXIE.

In regard to Ethan Viall's criticism of multiple tool boring heads on page 236, Vol. 32, I will say that we are using a number of them for boring cylinders, also for boring the guides of the engine frame. I find that we can pull a larger cut and remove more stock with four cutters than it is possible to do with one; and as for chattering, one tool will chatter if not properly ground. We use for roughing a four-cutter head with tools evenly spaced. For boring guides this is a good arrangement as only two tools are cutting at one time, thereby making it possible to double the cut. For finishing we use one tool and a wide feed with a light cut.

Mattoon, Ill. O. A. REICH.

Shrinkage Rule

On page 967 Martin H. Ball describes an adjustable shrinkage rule attachment. In most small pattern shops the ordinary rule with certain fixed standards as 1/8 inch in 12, 1/10 inch in 12, 3/16 inch in 12, etc., on its different edges is sufficient and any special scale is required but seldom. When one is required the correct lengths may be gotten as shown in the sketch. Drill a hole the size of any suitable brad at each end of a jointless straight rule, as at *A B*, on such an angle with the straight edge of the board, *C D*, that *C D* will equal the total length of the rule plus the shrinkage desired in that length. Square across from the dimension on *A B* and measure the length *C E* which will be the required length plus shrinkage. The ordinary two-foot shrinkage rule may be used, using the standard scale if it has one. If not, any scale smaller than the desired shrinkage may be used, care being taken that the angle is such as to give true reading and shrinkage on *C E*.



SPECIAL SHRINK RULES

Of course, the angle may be determined in the first place instead of by trial, by making the difference in the distances *A C* and *B D* equal to the square root of the difference in the squares of the two long sides of the triangle.

Joliet, Ill. E. W. FISKE.

Terminal Pressures in Hydraulic Accumulators

On page 236 Gerald E. Flanagan takes issue with me on a comparison which was made between two accumulator plungers on page 934, Volume 31, Part 2.

In the first place, the comparison was made merely to determine which, if either, of the two rams would produce the greater pressure in the system by its fall and I purposely disregarded the retarding action due to friction and to the water pressure and assumed that the water was "suddenly removed." It is certainly possible, although it would rarely happen, for several large valves to be opened at once which would have a very marked effect on the fall of the plunger.

If I was wrong in my assumptions to an extent that would change the results so that one of the plungers would give a higher theoretical pressure than the other I would appreciate to be set right. Regarding relief valves, which I mentioned, the valve I had in mind was not one which permits the water to escape but a spring-loaded plunger such as Mr. Flanagan describes. The choice of the name "relief valve" was merely unfortunate.

Regarding the nest of springs which "receives the falling mass and acts as a buffer," it is my opinion that this is provided to save the foundation or base of the accumulator rather than the piping system, as it would be easily possible for very heavy shock to be transmitted to this piping by closing the valves just before the springs are reached and the ram had descended nearly its full stroke.

Chicago, Ill. W. E. MOREY.

Steady Pins in Engine Feet

The illustration which Engineer gives at page 70 of "Things that Are Usually Wrong," seems to me to beg the whole question of the actual purpose of steady pins.

Undoubtedly if resistance to shearing strain is the only object, a key is preferable to a circular pin of less area, but I would suggest that "locating" pin is a more appropriate term than "steady" pin, and that its ordinary use is to locate a fixture rather than overcome any tendency to movement. Moreover as the locating pin or key must be fitted after the position of the fixture carrying it has been determined to use a key must present a deal of difficulty. The keyway in the cylinder foot, I take it, is machined previous to erection, and when the true position of the cylinder has been found and the corresponding keyway marked on the bed plate, the cylinder would again be lifted to enable the bed-plate keyway to be cut.

This must needs be a very accurate job to insure the cylinder returning exactly to its original position which is, of course, very necessary, and in doing this the object of locating pins is entirely defeated, which object is, I submit, to render fitting holes unnecessary and to allow for any discrepancy in machining to be obviated previous to finally fixing.

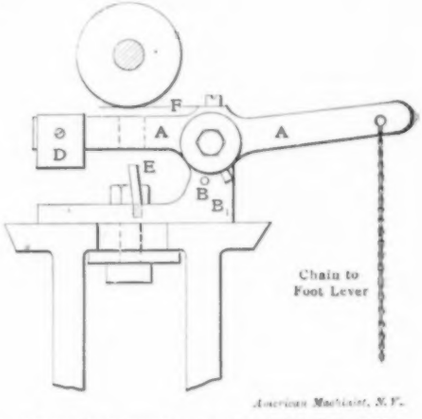
If keys are to be used in preference to pins why not cast a central web on the feet of the cylinder and cut a corresponding channel in the bed plate right away?

If I "had been fitting round pins for 40 years and never had a complaint before," I think I should be sufficiently conservative to stick to my standard methods, even if in one particular case it was necessary to bow to the "fad" of a person whose job, let us not forget, is dependent upon his ability to find fault.

London, England. WASHINGTON.

Screw Slotting Attachment for the Lathe

At page 973, Vol. 31, Part 2, is described a rig for slotting screw heads. At the first glance I thought that I had run against an old friend, but closer inspection proved otherwise. When I was a "nipper" the first machine that I ever worked at was a lathe rigged similarly to the one shown in the sketch of G. J. T.,



SCREW-SLOTTING ATTACHMENT FOR THE LATHE

with this difference: Instead of the upward thrust it was a downward pull which did the business. The accompanying sketch shows pretty clearly what I mean. Of course, with the alteration of the direction of thrust, the fulcrum of the lever is on the opposite side of the lathe bed to that of the arrangement described by G. J. T. Through the lever *A*, which carries bushes for the various sizes of screws, a hole was drilled and a piece of chain passed through it to a foot lever (not shown). Thus the foot was used for the pressure, leaving both hands free and the weight *D* at the end of the slotting lever counterbalancing the foot lever, dropped the screw on the release of the foot, to be shot out by pin *E*. The bushes holding the screws were held by a small headless screw.

The depth of cut could not be too deep, the pins *B* and *B*¹ coming into contact before this could take place. The conditions were exactly identical with the case described at page 973; that is, we used an old lathe and a circular saw between centers, spring *F*, etc.

Bradford, England. BOB.

Theory and Design of Friction Clutches

I read Michael Richard Conway's article on page 254 and then re-read it; the interest taken being principally from the number of points in which I disagree with him.

It was his statement in the last paragraph which caused the re-reading. The writer has never seen an "adhesion clutch," but is fairly familiar with friction clutches. Mr. Conway's statement that "When the motions cease to be different friction ceases" is the most remarkable one. If a piece of soft, warm, chewing gum is pressed against a piece of smooth wood it will stick there. Invert the board so that the gum is hanging down and it still sticks, in other words it *adheres*. Take two pieces of smooth, gray iron, the longer one being horizontal, and place the smaller one on top. Elevate one end of the longer piece and the smaller one will remain stationary, in its relation to the longer one, until the natural tangent of the angle of elevation equals the coefficient of friction between the two surfaces, at which point the smaller block begins to slide on the larger one. Mr. Conway seems to think that there is friction only when the block begins to slide; whereas most engineers consider that the friction exists all the time, but that when the angle of friction is reached the force of gravity overcomes the friction between the two surfaces. Certainly the two blocks of metal do not *adhere*. The only friction clutches I ever saw that were of the adhering style were those that seize or freeze together, and certainly no one wants that style; therefore, let us not change the term of "friction clutch" to "adhesion clutch" for the first name is correct and the second term wrong.

Lubrication

Having started at the end of Mr. Conway's article it will now be in order to take up his next statement, which is the fact that the addition of a lubricating oil to the hub and band of the clutch increases the friction by 20 per cent. Mr. Conway says that, "It developed that the pressure on the scales was 1/5 greater with the surface lubricated with mineral oil than when dry, under the same conditions and with the same pressure;" and he states that it is a paradox; while the writer considers that it is one of those things that is not so. Undoubtedly his observation of a 20 per cent. increase of pressure on the scales was correct, but his conclusion is wrong. There are, of course, many intelligent machinists, who in their youth, have been set to turning ringing fits and because of their youth and inexperience have unfortunately made some of the fits loose, dry ones. Some kind bench friend or their own ingenuity, has caused them to discover that the addition of oil on the dry surface will produce a ringing fit; the film of oil being thick enough to make the hole tight on the shaft. Some of us have seen an experiment of a 6-inch cast-iron shaft running several thousand revolutions per minute in a cast-iron bearing when dry; and have seen the same shaft stop at once with the addition of a small amount of good lubricating oil. Mr. Conway says that the pressure was the same in the case above stated, by which I understand him to mean that the friction collar, or band, was set up with the same pressure, or it might be better to say with the same leverage in both cases, for, of course, the pressure must have been different after the introduction of the oil. The film of oil was thick enough to increase greatly the pressure between the friction collar and hub, so much that the total friction measured off from the platform scales was increased 20 per cent., although undoubtedly the coefficient of friction of the surface was altered by the addition of the oil.

Slip and Heat

The statement in the third paragraph from the end attracts attention as we make our rearward progress in the article. Mr. Conway supposes an increase of 300 per cent. in the diameter of the friction hub with a corresponding increase in the peripheral speed of 300 per cent., and states that, "the latter speed would create three times as much heat at the same pressure and in the same time as the former," which statement is correct if both frictions are slipping with the same angular velocity. However, one must judge that the slip and heat is produced by picking up the load, and the inference is that the load is the same in both cases. Now if a 4-inch friction drum slipped through 360 degrees in picking up a load with a given pressure of friction band against the friction hub, then it must be evident that the 12-inch diameter clutch with the same pressure between the band and hub will slip through but ⅓ the number of degrees, and that the surface will slip for the same number of feet. If the pressure between the surfaces on the 12-inch clutch is ⅓ of the pressure on the 4-inch clutch, then the larger clutch will likewise slip through 360 degrees in picking up the load and the heat in all three cases will be the same.

In all the matter on page 255, beginning at the bottom of the first column, Mr. Conway assumes that the pressure is constant for each square inch of the band around the hub, and in Fig. 3 is illustrated a hub clutch with what appears to be a semi-flexible band pressed about the hub by a draw bolt operated by a lever. I greatly question the correctness of this assumption. The band is semi-flexible and, therefore, the compound interest effect of friction on the flexible band wrapped around the pulley must greatly influence the amount of pressure and some portions of the band must press against the hub much harder, and consequently with greater friction than other portions. I am not a professional designer of friction clutches, although like most mechanical engineers, have done something in that line and the first thing that struck me as strange in Mr. Conway's article was the fact that he figures on the area of surface in the friction clutch and I shall be much interested to read the comments of other professional friction-clutch designers on his article.

Pressure Allowance

Mr. Conway's investigation of the actual surface of contact is without question of value, and his statement that the pressure on one square inch of band surface, when the hub is 4 inches in diameter, is 55 pounds for a 1-horsepower clutch is interesting. Kent records that Thornycroft allows 50 pounds per square inch for thrust bearings for propellers, and this is for a constant slip and slide, while the friction clutch does not have a constant slip and slide, but is intended to slip only when picking up a load easily, as any operative will start up a friction slowly in order to keep the belt from flying off under possible quick starting of the line shaft. I should judge that the pressure between band and hub on most friction clutches in ordinary practice are subjected to a very much higher pressure than 15 pounds per square inch, or indeed to the actual 55 pounds per square inch, as found by Mr. Conway. Ordinary journal bearings have frequently 200 pounds per square-inch pressure for a constant slide, and certainly the friction clutch which slides, but for a few seconds only could easily have greater pressure without injury to the surface and, of course, they must have. Mr. Conway's article reads as though the friction clutch was slipping all the time instead of which we know that the pressure between the two friction surfaces must be great enough to produce friction so the slipping will not occur.

Just under Fig. 5 at the end of the paragraph Mr. Conway states, "To increase the efficiency from 13.75 to 55 offers a big field for improvement, that should not be overlooked by the ambitious mechanic." I have read the sentence several times and have failed to grasp the meaning. Mr. Thornycroft seems to think that 50 pounds for a constant slip is all right, and Mr. Conway proved that a 4-inch clutch slipping to equal one horsepower calls for 55 pounds per square inch, therefore, what more is there to think about? Mr. Thornycroft knows that 50 pounds per square inch is all right for a constant slip and Mr. Conway proved the same thing, so, what improvement can an ambitious mechanic make?

Worcester, Mass. Clinton Alvord

A Year's Industrial Accidents in Pittsburg*

Causes of Fatal Accidents—Personal Carelessness 28 Per Cent., Employer's Responsibility 30 Per Cent., Both 16 Per Cent., Neither 26 Per Cent.

BY CRYSTAL EASTMAN

The gravity of this problem it is hardly necessary to point out. In the year just preceding the recent financial depression, when industrial activity was at its hight, that is, from July 1, 1906, to June 30, 1907, 526 men were killed in Allegheny county by work accidents. During the same year the hospitals of the country received over 2000 men injured in such accidents. It is impossible to state with any accuracy what was the total number of nonfatal injuries during the year, for of those cases which are not sent to the hospital, there is no available record. All the large companies and many of the smaller ones keep complete reports of every accident, but these are not open to the public.

But, even were it possible to make an accurate estimate of the injuries of a year, it would be of little value; a scratched finger and a lost leg cannot be counted together, if you desire to reach any useful truth in the sum. It is better not to attempt to estimate the total number of injuries in a year, but to concentrate our attention on the permanent loss of health and power, involved in those 2000 injuries we are sure of.

First, we must know the trail of lasting miseries which such accidents leave behind. In 294 out of the 509 nonfatal accident cases of which we have record, it has been possible to learn the nature and extent of the injury. One hundred and twenty-seven of the men escaped without permanent injury, 91 sustained what we have called a slight permanent injury; for instance, a lame leg, arm, foot, hand or back, not serious enough to disable a man; the loss of a finger, the slight impairment of sight or hearing, and other miscellaneous injuries. Seventy-five men (25.5 per cent.) suffered what we have called serious permanent injury. Lest there should be doubt as to what is meant here by "serious," we will state exactly what these injuries were: Seven men lost a leg, 16 were hopelessly crippled in one or both legs, 1 lost a foot, 2 lost half a foot, 5 men lost an arm, 3 lost a hand, 10 lost two or more fingers, 2 have a crippled right arm, and 2 have two useless arms; 11 men have lost an eye, 3 others damaged the sight of both eyes. There are two men with a crippled back, 2 with internal injuries, 1 partially paralyzed, 1 feebleminded, and 2 stricken with the weakness of old age while still in their prime. Finally there are 3 men suffering from a combination of permanent injuries. One man has a rupture and a crippled foot; another the left leg crippled, and the right foot gone; the third an arm and leg gone. These 75 are the wrecks out of 294 hospital cases.

Apply these proportions to the 2000 hospital cases for the year and we have the Pittsburg district sending out from its mills, railroad yards, factories and mines every year, 50 one-legged men, 100 hopeless cripples walking with crutch or cane for the rest of their lives, 40 men with a twisted, useless arm, 30 men with an empty sleeve, 27 men with but one hand, 60 with half a hand gone, 75 one-eyed men, etc.

Five hundred and twenty-six men dead, does not necessarily mean 526 human tragedies. We all know men who would give more happiness by dying than they ever gave by living. But 517 mutilated men; here there can be no doubt. . . . And time goes on. There is no respite. Each year turns them out as surely as the mills run full and the railroads prosper—as sure as times are "good." In five years there would be 2585. Ten years would make 5170—enough to make a little city of cripples—a number noticeable even among Greater Pittsburg's 600,000. It is no wonder that for a stranger Pittsburg's streets are sad.

This steady march of injury and death means suffering, grief, misery, bitterness, thwarted hopes incalculable. These things cannot be reckoned, they must be felt. But there is a loss of youth and strength and wealth-producing power involved in those 500 yearly deaths, and in those 2000 yearly injuries which can be set forth in figures. It is a direct loss to the community of which these workers were a part, and it will be worth the while of that community to notice it.

Fatal Accidents Are to Young Men

From the point of view of social welfare, the gravest feature of the situation is that the men who are being killed in industry are young men. Eighty-four per cent. of the men in the year's list of deaths were not over forty. Fifty-eight per cent. were not over thirty.

Age.	No.	Per Cent.
Under 21	82	16
21 to 30	221	42
31 to 40	137	26
Over 40	86	16
Total	526	100

TABLE I. AGE OF WAGE EARNERS KILLED IN INDUSTRIAL ACCIDENTS IN ALLEGHENY COUNTY, PENN., JULY 1, 1906, JUNE 30, 1907.

Pittsburg people quite generally have an idea that it is the common foreign laborers and not the American workmen who are being killed and injured in such numbers every year. Whether or not there is any moral comfort in this idea it must be abandoned; 228 or 42.5 per cent. of the men killed during the year were American born.

Industries in Which Employed.	Aggregate.	Country of Birth.						
		America.	Austro-Hungary.	Italy.	Ireland.	Germany.	Other Countries.	Country of Birth Unknown.
Steel manuf're	195	51	117	10	9	4	2	2
Railroading	125	89	15	12	3	2	2	2
Mining	71	14	34	18	2	1	2	0
Other ind'tries	135	74	23	19	4	5	9	1
Total	526	228	189	59	18	12	15	5

TABLE II. 526 WAGE EARNERS KILLED IN INDUSTRIAL ACCIDENTS CLASSIFIED BY INDUSTRIES AND COUNTRY OF BIRTH.

It is a mistake, also, to suppose that it is the cheap, unskilled labor which suffers most from industrial accidents. In the Pittsburg district, generally speaking $1.60 a day, or $9.60 a week is good pay for common labor. Only 16 per cent. of the men killed during the year (whose earnings were ascertainable) were in this class of labor. Including those men in the steel mills who work seven days a week for $1.65 a day, making a weekly wage of $11.55, we have but 32 per cent. unskilled.

Weekly Earnings.	No.	Per Cent.
Under $10	71	16
$10-11.99	71	16
$12-14.99	89	20
$15-19.99	158	36
$20-29.99	44	10
$30 or over	7	2
Total	440	100

TABLE III. WEEKLY EARNINGS OF MEN KILLED IN INDUSTRIAL ACCIDENTS.

There is no bright side to this situation. By industrial accidents, Allegheny county loses more than 500 workmen every year—nearly half of whom are American born, 70 per cent. of whom are workers of skill and training, and 60 per cent. of whom have not reached the prime of their working life. Youth, skill, strength, in a word, human power, is what we are losing.

Is this loss a waste? This is a question which Pittsburg and every district must take time to study. If it is merely an inevitable loss in the course of industry, then it is something to grieve over and

*Condensed from the Pittsburg Survey in *Charities and the Commons.*

forget. If it is partly, or half, or largely an unnecessary loss—a waste of youth and skill and strength—then it is something to fight about and not forget.

Groupings as to Cause

One cannot read the records of 526 industrial accident inquests, without beginning to group them in one's mind according to the personal equations entering into their causes. On the groupings which thus naturally suggested themselves I have based this analysis. The accidents were studied first of all from the statements of those who testified at the inquest. These coroner's records, it is true, are as a rule meager, sometimes illegible, and almost never clear and satisfactory in detail. The testimony, moreover, has a decided tendency to lean to one side. The witnesses are employees of the company, including almost always the superior of the man killed. His chief interest is naturally to clear himself of all complication, and second to clear his employer. The easiest and safest way of accomplishing these ends is to blame the dead man. The same motives, in perhaps lesser degree, are with the fellow workmen who testify. This version of the accident, however, we were able to supplement and modify in many cases by what was learned in visiting the case, from witnesses, or privately from fellow workmen. Finally an effort was made to compare these accounts of the accident with the employer's record of it, or to get from him a written statement of the nature and cause of the accident. Such information was secured in 191 cases.

On the evidence obtained from all these sources this table of responsibilities is based. It is not a tabulation of proved conclusions, but of indications. Whenever in any of the versions of the accident some responsibility is indicated, that indication is included in the tabulation.

Industries in Which Accident Occurred.	Cases in Which Indications Attribute Responsibility.				
	To Victim.	To Fellow Workmen.	To Foreman, Etc.	To Employer.	To None of These.
Steel manufacture.	45	28	16	48	52
Railroading.....	16	12	9	32	22
Mining.....	31	5	11	14	25
Other industries...	40	11	13	53	18
All industries.....	132	56	49	147	117
Percentage of total fatalities consid'd	32.19	13.65	11.95	35.85	28.54

TABLE IV. INDUSTRIAL ACCIDENT FATALITIES CLASSIFIED BY EMPLOYMENT AND BY RESPONSIBILITY.

An accident is checked up against the victim of it, if his act or omission in any way contributed to it, whether it was due to his carelessness, ignorance, or any other failing. The same rule is followed in the "fellow-workmen" column. Between accidents attributable to the employer and those attributable to the superintendent or foreman, a rather sharp and arbitrary line was necessarily drawn. If the accident was due to some defective condition in the working plan or appliances, the furnishing of insufficient or inadequate material, etc., it was checked in the "employer" column. But if the accident was due to some special failure in superintendence, as for instance, placing ignorant men in dangerous positions, failure to warn, mistaken and dangerous orders, then it was credited, not against the employer, but against the superintendent or foreman.

The Inevitable Accidents

This table has at least a certain negative usefulness in disproving conclusively the statement that 95 per cent. of the industrial accidents are due to the carelessness of the workmen. For 28 per cent. of the year's fatal accidents according to all the evidence attainable, no one is to be blamed. The fatalities in this last group would commonly be called unavoidable. In this case we have placed the two great furnace explosions at the Jones & Laughlin Steel Works, one in January and one in May, in which altogether 19 men were killed. Those whose testimony was available exonerated all concerned from responsibility for these two explosions. Here, too, belong most of the cases of asphyxiation by furnace gas.

There is little use lingering on this class of accidents. One cannot point to any very immediate hope of prevention. Safer ways of doing many things will in time be devised, but there will always be dangerous trades. My purpose in dwelling just here upon these accidents is to make it clear that since 26 per cent. of the fatalities are of this "unavoidable" kind, it cannot be true that 95 per cent. are due to the carelessness of the men killed.

Ignorance, Youth, Unfitness

In fact, considering all the evidence available, we had indications of the victim's responsibility in only 32 per cent. of these fatalities. And even this 32 per cent. demand analysis. They present not just "carelessness" as we commonly use the word, but a long list of human weaknesses, some common to us all, some resulting from special environment; some for which the man himself is not responsible, some for which he is responsible.

Ignorance covers a large share of these cases, the ignorance of young boys—the ignorance of those who are "green" at their job—the ignorance of the tongue-tied alien, who finds himself for the first time a part of swift and mighty processes. In 22 out of 132 deaths in which the victim can be held accountable, he was "green." One was on his first night's work in a mill; another three days; 8, less than a month; 4, less than two months; 7, less than six months. Nearly all these men were foreigners and 8 of them had been among English-speaking people less than one year.

Thirteen of the 132 who were in a measure responsible for their own deaths were not men but boys. Two boys were killed in the Homestead steel works while they were asleep. Both accidents happened at 1:30 in the morning. Many kinds of carelessness which we should heartily condemn in a grown man must be expected in a boy. For this reason we must class these 13 cases with the 22 cases of ignorance. A boy cannot be blamed for being a boy any more than a foreigner can be blamed for being a foreigner. The hope of preventing such accidents lies possibly in restricting the employment of boys and ignorant foreigners in such work, possibly in more adequate superintendence of their work.

Next there were 12 deaths due to a condition on the part of the man killed over which he had no immediate control.

We have now covered 47 of the 132 fatalities, which would be put down upon the average employer's record as "due to carelessness." We find that in 22 cases the "carelessness" is ignorance; in 13 cases it is youth; in 4 cases it is physical weakness; in 8 cases it is drunkenness. We are left with 85 cases—a large number—in which there is indication, strictly speaking, of "carelessness" in one of its many forms.

Summarizing, instead of 95 per cent., we find that only 32 per cent. of the fatal accidents can be laid to the responsibility of the victims. And dissecting this 32 per cent., we find 11 per cent. not due to carelessness, strictly speaking, but to ignorance (5 per cent.), to youth (3 per cent.), to physical weakness (1 per cent.), and to drunkenness (2 per cent.). This leaves us of the fatalities but 21 per cent. of men whose deaths were due, wholly or partly to their own carelessness, reveals that some of these men were heedless, some inattentive, and some rash.

Part Played by Fellow Workmen

Those accidents which involve the responsibility of a fellow workman of the man who is hurt, are subject to a similar classification. Of 24 out of 377 accidents some act or omission on the part of fellow workmen was the sole cause. Several of these were cases of ignorance or incompetence.

The Employer's Responsibility

Referring back now to Table IV, we find that 147 of the deaths, or 35.85 per cent., can be laid to the responsibility of the employer.

Most of these 147 accidents were due to a failure in what has been called the employer's "first duty," to provide a safe place to work. They divide themselves into two main groups. In the first come those accidents which are due, strictly speaking, to defects, i.e., some condition

of plant or appliance which was not planned or intended.

Deliberate Disregard for Safety

The second group of failures in "the employer's first duty" is of a very different nature from these "defects" we have considered. Lack of reasonable provision for safety and construction of a plant, or in the organization of the work is part of the plan, deliberate and intended, and is hard to find excuse for it. Under this heading come a large number of fatalities.

To sum up the employer's relation to industrial accidents, we have found revealed in the history of one year's fatalities much deliberate disregard for safety in the construction of plant and equipment, and in the organization of work; we have found a long list of defects, not all of which the employer could have avoided, but most of which a careful inspection would have revealed and immediate repair have rendered harmless; we have found those directly representing the employer in positions of authority, often unregardful of safety; we have found children regularly employed in work, or in surroundings that mean danger to them on account of their youth.

Analysis of Fatal Accidents

We set out to discuss the different human agencies involved in the causing of industrial accidents, taking one year's fatalities in Allegheny county as a basis. For some minds analysis is so great a delight as to be an end in self; but it is in quite another spirit that we have attempted to make clear the relation of workmen, superintendents and employers to the happening of accidents, and to search out and define the various elements in the so-called negligence or "carelessness" of each. A revelation of the causes must point to the cure. If we have succeeded in this analysis and if we have carried the reader with us, then we have thrown some light upon the problem of preventing accidents.

	No.	Per Cent. of Total.
Accidents—cause of which is attributed solely to those killed or their fellow workmen	105	27.85
Accidents—cause of which is attributed solely to employers or those who represent them in positions of authority	113	29.97
Accidents—cause of which is attributed to both the above classes	60	15.91
Accidents—cause of which is attributed to neither of the above classes	99	26.26
Total	377	100.00

TABLE V. INDICATIONS AS TO RESPONSIBILITY FOR INDUSTRIAL ACCIDENTS RESULTING IN DEATH.

Take first that 29 per cent. of fatal accidents attributable solely to the responsibility of employers, or those who represent them in positions of authority. The deaths due to a deliberate lack of provision for safety in the construction of the working place and in the general plan of work might have been avoided by deliberately providing for safety in such construction and organization; the deaths due to the employment of children at unsuitable work could have been avoided by not employing children; most of the deaths due to defects in plant or equipment could have been avoided by a more frequent and careful inspection and by immediate repair; many of those deaths due to incompetence, indifference, etc., in superintendents and foremen would not have occurred if these men had been made to feel that without exercising skill and care in safeguarding the workers, they could not make good. In short, if by any form of persuasion or compulsion, we could bring it to pass that the desire to prevent accidents should be a chief motive with employers at all times, present at times of construction, present at times of engaging and organizing and changing the force, present through every day of operation, we could largely do away with this first 29 per cent. of fatal accidents.

With the second group, the 27 per cent. attributed to those killed or their fellow workmen, we must go back to our analysis of the "careless workman" in order to suggest the lines of possible prevention. Where "carelessness" is youth or ignorance or weakness, there is a remedy. Minimum requirements of age, experience or physical fitness can be established for certain dangerous occupations; but there would be many limitations to enforcing such tests. To do away entirely with accidents of this class, the "prevention motive" in the employer must be so strengthened that no hope of profit will induce him to employ boys in the mills, no stress of competition, no emptiness of the labor market, induce him to employ foreigners in positions where, through their ignorance, their own lives or the lives of others are endangered.

The man who goes to his work intoxicated, the heedless fool—these also we must leave the employer to deal with. Discipline alone can prevent their being dangerous to themselves and to others.

That "carelessness" of workmen which is mere human nature, only slow processes of education can be expected to lessen. Here we cannot say, create a motive for carefulness in those who lack it, for the very strongest motive is already present, the preservation of life and limb. But long hours of labor, from which comes so much of the "carelessness" that is inattention, are not an inevitable condition of production. Here, at least, the State can act directly, if it will.

Finally, the high speed and unremitting tension, characteristic of all our industrial activities, which are the other great causes of inattention, and which are also the means of encouraging, and increasing recklessness in the workers, can be lessened. But here, again, the State can do little in a direct way, so long as competition inspires, creates, and rules those industrial activities. The only way is to make the lives and limbs of his employees as important to an employer as the output.

Among all these different groups of accidents we find many to be immediately preventable. Often these, the main causes, are:

Faults in construction.

Long hours of work.

Too great speed maintained in almost all lines of work.

Inadequate inspection.

Failure to remedy known defects.

Inadequate warning and signal systems.

Inadequate instruction and direction of ignorant workers.

I have separated the first two sources because they chiefly indicate the direct line of attack. If the people of Pittsburg wish to reduce their industrial accident rate, they can begin by working for a better factory act, making its safety requirements more definite and capable of enforcement than the present ones, and extending those safety requirements, so as to cover, for instance, the stringing of electric wires in mills, the placing of hand rails along crane runways, etc. They can look up their railroad law, and they will find that it contains no safety provisions, although Ohio, next door to them, requires blocked frogs, automatic couplers, and footboards and grab irons on all yard engines. By carefully framed and enforced criminal statutes, dealing with safety provisions in mines, mills and railroads, much can be done to decrease the accidents from faults of construction.

In the second place a shorter work day in all employments where accidents are common can be secured directly by legislation. This, if established and enforced, would greatly decrease those accidents due to inattention on the part of foremen and workers.

An Old and Unsuccessful Way of Turning Tapers

By A. Dutcher

In the fall of last year and in a shop not 15 miles from New York, the gang boss Joe, said to one of his men, "Jim, I want you to lend a hand here. Turn this forging the same as I am turning this one."

Jim soon had his piece between centers in the next lathe and then walked across to Joe's lathe and examined the carriage to see if it was twisted out of square with the lathe bed. When he saw that it was O. K. he did a little tall thinking with the result that he got a pinch bar and slewed one end of his lathe about six inches across the floor and ran a cut across his forging.

Of course it is not necessary to add that Joe finished that job and Jim's name is now Walker.

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Metric Tradition in the Making

In the first number of the *Journal of Weights and Measures,* to which we referred in a recent editorial, we find a new illustration of the remarkable capacity of the metric party for distorting facts. At the beginning of an article on the metric system under the sub-title, "Editorial Note," we find the following:

"There is a popular notion that the weights and measures of England and the United States are the same, whereas they are not, only being similar in name."

On the page following this statement, and in the same article, we find figures for the values of the British and United States yards as follows:

1 yard (U. S.) = 91.4402 centimeters, 0.9144 meters;

1 yard (British) = 91.4399 centimeters, 0.9144 meters.

Does the reader infer, as he is expected to infer, that the discrepancy noted is the result of camparisons of the English and American yards with standard meters? If so, he is mistaken.

The only excuse for the setting forth of this equivalent is to be found in the act of Congress of 1866 by which it was made "lawful throughout the United States of America to employ the weights and measures of the metric system," the act including tables of equivalents to be "recognized in the construction of contracts and in all legal proceedings," and establishing those equivalents "in terms of the weights and measures now in use in the United States."*

In this act the equivalent of the meter was cut off at two decimal places and given as 39.37 inches, this value being amply sufficient for the purposes of the act, the true value being, in fact, then unknown, and the equivalent of the American yard given by our contemporary is nothing but this ratio inverted.†

That is to say, an equivalent intended to be used "in the construction of contracts and in all legal proceedings" and which defines the metric in terms of the English unit is now used as though it defined the English in terms of the metric unit, which it does not, and as though it were intended to be exact, which it was not, and, by simple inversion, a value of the yard is found which necessarily differs from the true value of the English yard, and the result is triumphantly placed before the reader as proof that the two units are "similar only in name." And the reader in this case is the official sealer of weights and measures, who is thus being "educated" to become a metric missionary as he circulates among the people in the discharge of his official duties.

The facts are the exact opposite. In Appendix 18 to the Report for 1890, by O. H. Tittman, then assistant-in-charge of the Office of Weights and Measures, and published from the Government Printing Office in 1891, we find the categorical statement: "There is no difference between the customary unit of length of the United States and of Great Britain."

And this is not all nor the worst. The *Journal of Weights and Measures* is of small importance alongside the American Society of Civil Engineers, and that society, by giving circulation to the report of its committee on the metric system, spreads among its members and gives sanction to indefinite repetition of the committee's false statement: "The law of 1866 fixes the length of the foot by specifying the legal equivalent 1 meter = 39.37 inches (exactly). This act thus increased the American foot by 0.004 millimeter = 0.00016 inch, so that our foot is slightly different from the old British foot."

The difference claimed is, of course, small, but the principle is large, and in future citations the figures may be, and will be, conveniently ignored. How far this may go we see already in the quotation from the *Journal of Weights and Measures* wherein the British and American units are said to be *similar only in name.*

When the metric case is reduced to this it would seem to be on its last legs, but is it? We shall see what we shall see.

*The quotations are from the act cited.

†The approximate equivalent of the meter being given as 39.37 inches, or $\frac{39.37}{36}$ yard, the yard, by this simple process, becomes $\frac{36}{39.37}$ meter, and if the reader will make the division he will find the result to be 0.914402, as given by our contemporary.

Special Fixtures for Machine Tools

Special fixtures for any machine tool are very desirable in many cases, and yet in others they are a waste of money. The man who can decide when it pays is the one who makes the successful foreman, superintendent, or manager.

The toolmaker in the small shop with only a lathe and perhaps a drill press is usually justified in making fixtures for using his lathe as a milling machine and gear cutter, or perhaps even as a shaper or slotter on special occasions, but it would be folly to do this where these machines were available as it ties up a lathe and cannot be as efficient as a machine built for that purpose.

There are many cases where a lathe that becomes a back number on account of its inability to stand up under the heavy cuts of the present day, may be converted into a machine for some special purpose, such as a light pulley turner and crowner, a machine to cut air grooves in the pulley, or as a grinder for some special work. Care must be taken that the

cost of alteration is not too high nor the output too low when compared with a new machine for the purpose.

Care must also be taken that we do not tie up an expensive machine to do the work of a low-priced one, as would be the case of using a large milling machine to spline a lot of shafts that could be done in a much cheaper machine unless, of course, the milling machine would be standing idle during this time.

Any special fixture which will increase the output of a lathe *as a lathe*, or a planer *as a planer*, will pay if their work is done in sufficient quantity, but when it comes to making one machine do the work of another, it is always well to give the situation a careful looking over from all sides as there is grave danger of showing an increase of cost instead of a reduction, when all things are considered.

Award of the John Fritz Medal to Charles T. Porter

The John Fritz medal for 1909 has been awarded by the board of award specially selected for the purpose and consisting of four members of each of the national engineering societies, to Charles T. Porter, Hon. Mem. Am. Soc. M. E., for his work in advancing the knowledge of steam engineering, and in improvements in engine construction.

The public ceremony of the presentation of the medal to Mr. Porter will take place in the large auditorium of the Engineering Societies building, No. 29 West Thirty-ninth street, New York, at 8:30 p.m., on Tuesday, April 13, 1909. It is the wish of the board to give distinction to the event, and to make these awards year by year memorable and fittingly conspicuous.

Besides the simple ritual of the presentation of the medal, in the presence of invited guests and distinguished representatives of engineering, there will be addresses by representatives of the four groups of the profession most concerned.

The Debt of Modern Industrial Civilization to the Steam Engine as a Source of Power. Dean W. F. M. Goss, of the University of Illinois.

The Debt of the Modern Steam Engine to Mr. Charles T. Porter. Prof. F. R. Hutton, of Columbia University.

The Debt of the Era of Steel to the High-speed Steam Engine. Robert W. Hunt, of Chicago.

The Debt of the Era of Electricity to the High-speed Steam Engine. Frank J. Sprague, of New York.

William P. Henszey

William Peddle Henszey, member of the firm of Burnham, Williams & Company, known as the Baldwin Locomotive Works, died at his home in Philadelphia, March 23.

Mr. Henszey was an engineer of high standing and in his 50 years of service with his company had supervised the designing of more than 32,000 machines. In early life he developed a liking for mechanical and engineering studies and in 1859, at the age of 27, he became connected with the Baldwin Locomotive Works as engineer and draftsman, and at the time of his death had rounded out 50 years' service with this company. In 1870, upon reorganization of the company, he became a member of the firm and supervised the designing and manufacture of a large portion of their output.

Upon the recent occasion of his golden anniversary he was presented with a gold plate by the members of the firm. He was a man of large affairs in Philadelphia and was connected with many charitable and philanthropic institutions.

New Publications

FOUNDRY PRACTICE. By James M. Tate and Melvin O. Stone. 234, 5x7¼-inch pages; 112 illustrations. John Wiley & Sons, New York. Price, $2.

This book is presented as a textbook for the students in the College of Engineering of the University of Minnesota by two of its professors. The aim of the authors has been to present the subject in such a simple manner that the student who knows nothing about the foundry can readily grasp the subject. This object has been accomplished in a very efficient manner, and the subject covered from melting of the metal in the cupola or furnace to the dumping of the castings after pouring.

Green-sand and dry-sand molding and core-making are very well explained, as well as the nature and action of the sands and facings used. Iron, chilled, malleable, steel, brass and bronze castings are dealt with and the sands, molds, flasks, tools, melting apparatus and their fuels have been thoroughly explained. The machinery used for molding, core-making, melting, pouring, annealing and cleaning the casting has also been gone into quite thoroughly.

Five pages in the back are devoted to tables, but these are not very reliable, as we find in the melting point of metals that wrought iron is given as 3981 degrees Fahrenheit, and we find the same figures given in a book published about 15 years ago, indicating that the figures repeat a typographical error by which 3 appeared instead of 2; which would still be too high, as most authorities read between 2700 and 2800 degrees Fahrenheit. Gold and copper are given at 2587 and 2550 degrees, respectively, while both melt below 2000 degrees. Silver is given at 1250 degrees, although most authorities make this over 1700 degrees, and antimony is given at 951, while it is generally considered that it takes over 1100 degrees Fahrenheit to melt it.

A glossary of words and terms used in the foundry is given in the back of the book, and this is a very good feature, as its use will make the student much more familiar with the foundry.

While the book is written for the student it is also one of the best books on the subject for the apprentice, as the language is simple and easily understood.

Personals*

F. L. Morse, treasurer and manager of the Morse Chain Company sailed for Europe, March 31 in the steamship "Lusitania."

S. B. Redfield, formerly assistant chief engineer, Gas and Electrical Department, Ingersoll-Rand Company, recently joined the editorial staff of the AMERICAN MACHINIST.

Fred B. Franks, general superintendent and chief mechanical engineer of the Bath Portland Cement Company recently resigned his position. James A. Gist, assistant superintendent, left the employ of the company at the same time.

W. F. Rust, for the past two years assistant chief engineer with the American Sheet and Tin Plate Company, has become chief engineer of the Youngstown Sheet and Tube Company, with headquarters at Youngstown, Ohio.

William N. Parsons has become chief draftsman of the Buffalo Bolt Company, the works of which are located at No. Tonawanda, N. Y. Mr. Parsons was formerly connected with the W. P. Davis Machine Company, of Rochester, N. Y.

Robert Thurston Kent, for four years engineering editor of the *Iron Trade Review*, has become managing editor of *Industrial Engineering*, Pittsburg, Penn., a new paper devoted to mechanical engineering subjects.

Herbert L. Smith, designer and draftsman, of Clinton, Mass., and occasional contributor to our columns, sailed for Warrington, England, on March 23, where he is to establish a branch plant of the Clinton Wire Cloth Company, for the manufacture of wire fabrics and fencing electrically welded.

A. N. Alexander, who has been connected with the office of the General Electric Company's Lynn works for over twenty years will engage in another line of business in Boston. During the past few years Mr. Alexander has been at the head of the cost department of the Lynn works.

L. P. Breckenridge, professor of mechanical engineering in the University of Illinois, and well known in connection with the work of the United States Geological Survey, will have charge of the Sheffield Scientific School at Yale, in place of Prof. Charles B. Richards, retired. Professor Breckenridge will assume his new duties next September.

*Items for this column are solicited.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

A New Plurality Bolt Cutter

Since the first appearance of this machine about two years ago, the cone drive has given way to the geared-head machine, as shown. There is a friction clutch for stopping and starting and three speeds are secured by the use of tumbler gears controlled by the handle in front. All gearing, as well as the oil pump, is inclosed in the frame, which has a solid bottom that drains all oil to the pump after catching all the chips in a division for that purpose.

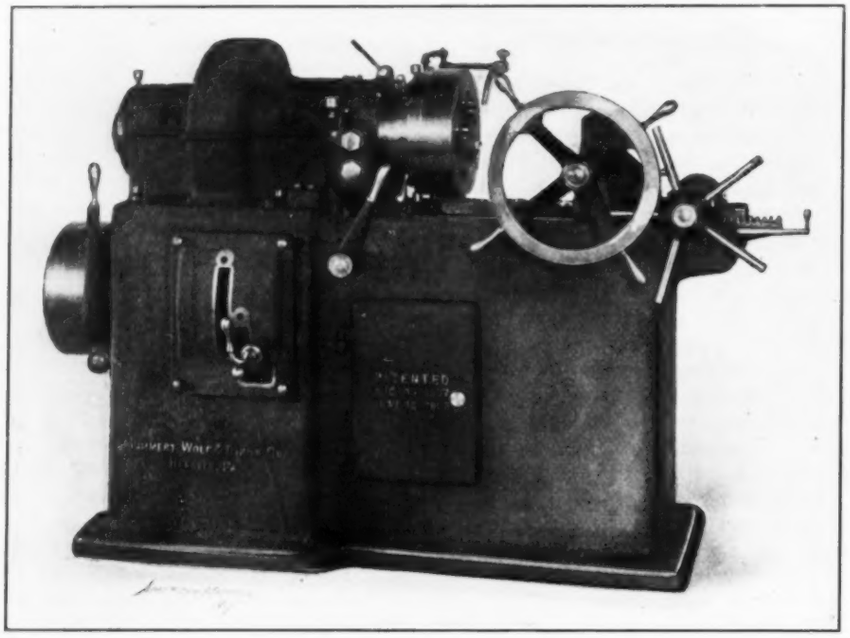


FIG. 1. NEW PLURALITY BOLT CUTTERS

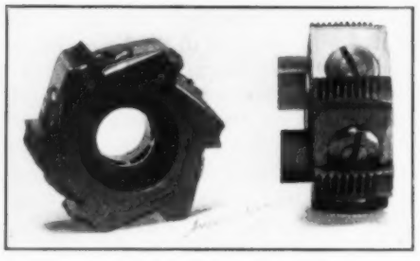


FIG. 2. THE DIE HOLDERS

It has the regular plurality die head, opened either automatically or by hand and allowing the die to be adjusted while running. The die can be changed to any size without removing from the machine and can be set by a graduated ring, to cut the correct diameter without trial. When closed for cutting it is practically a solid die. The vise jaws are adjustable sideways to allow of holding irregular pieces, but are locked central by a dowel pin. The construction of the dies has been changed somewhat, as can be seen in Fig. 2, the new method of holding being extremely rigid. The machine is built by the Mummert, Wolf & Dixon Company, Hanover, Penn.

Gear Hobbing Machine

In this machine, which is well illustrated by the accompanying halftones, the work is carried past the hob instead of the hob being traversed past the work; the head carrying the hob being fixed in position so that the problem of bringing the power to the hob is a simple matter. In order to make use of this construction and retain

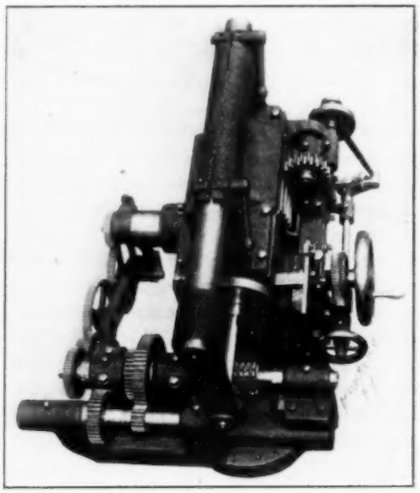


FIG. 2. GEAR-HOBBING MACHINE (TOP VIEW)

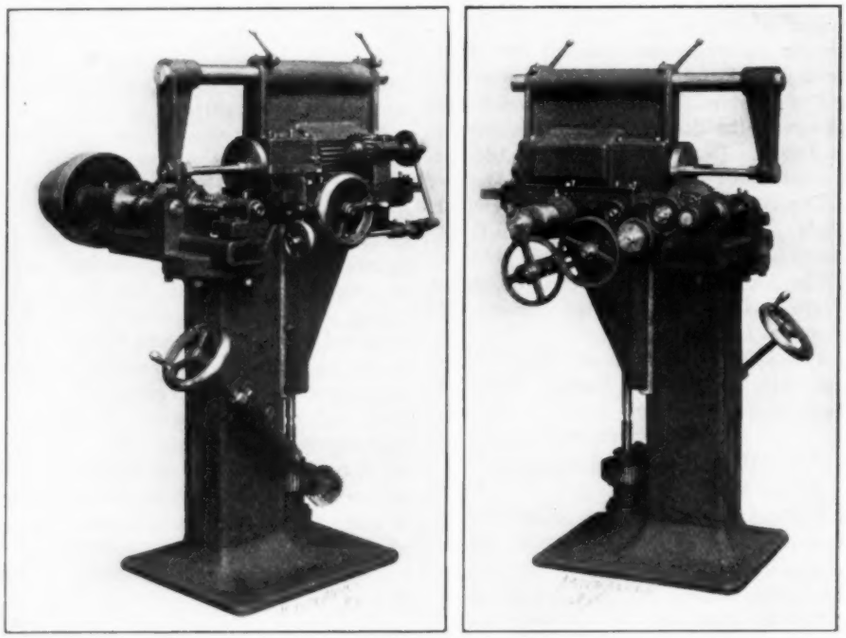


FIG. 1. GEAR-HOBBING MACHINE

the proper relationship between the hob and the work the hobs are made in sizes varying with the pitch, so that the thread angle of all hobs is the same. When this reduction of size of hobs with the finer pitches, makes the hob of too small diameter to be practical, multiple-thread hobs are used to bring up the size to reasonable dimensions.

As shown in Figs. 1 and 2 the work spindle is mounted in a sliding head and is driven by a broad face master spur gear. This gear is, in turn, driven by a worm of the same thread angle as the hobs. This brings the worm shaft and hob shaft parallel and makes the matter of their connection to secure the proper rotary speed of the work as simple a matter as gearing the lead screw of a lathe.

The feed of the head, in which is mounted the work spindle, is by two racks on the underside and pinions on a shaft fixed in the knee. This construction brings the thrust of the feed approximately in line with the thrust of the cut, being a little to one side on small gears and a little to the other on large gears. This naturally tends to reduce the wear on the head and equalize what wear there is, thus reducing to a minimum the liability of the head wearing loose in the middle.

The work arbor has an outboard support as illustrated. The machine is driven by a 3-step cone for a 3-inch belt, is back geared, giving six changes of speed in geometrical progression, and is built with special reference to the use of high-speed hobs. The size of machine now made will cut gears up to 12 inches diameter by 6-inch face and up to 6 diametral pitch in steel and 5 pitch in cast iron. It is built by the Reynolds Machine Company, Moline, Ill.

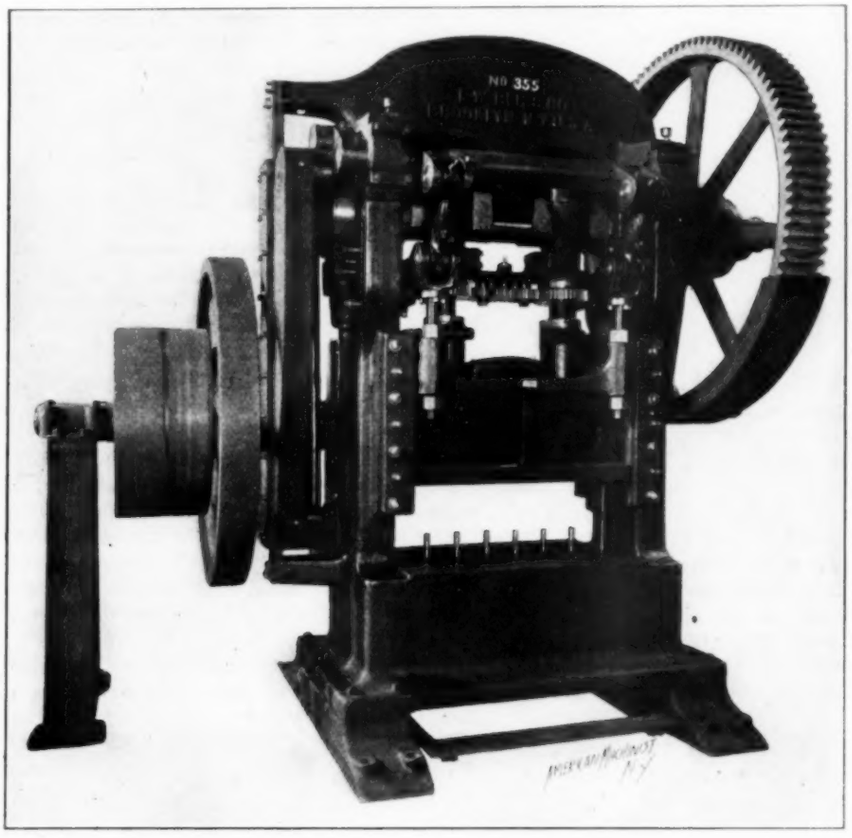
Double Crank Toggle Drawing Press

To overcome the objectionable features of drawing under rubber and spring pressure, especially in deep work, the E. W. Bliss Company, Brooklyn, N. Y., has designed a new type of press known as the double-crank toggle-drawing press, which is built in ten sizes. The first of this type press was made some three years ago, but the press shown has been redesigned to embody such changes and improvements as experience has demonstrated to be of advantage. The frame of this press is cast in one piece. The punch slide has a stroke of 8 inches, the pressure being distributed over two points, by means of screw connections, which are geared together, and work in unison when adjusting the slide.

The blank-holder slide, which has a stroke of 6 inches, incases the punch slide, and the pressure on it is distributed over four points by means of heavy steel screws. This slide is actuated by the Bliss patented toggle which receives its motion from the crank shaft through the medium of an outside slide, which slide is operated by a crank connection on the end of crank shaft. The blank-holder slide mechanism is balanced to avoid all undue strain. The construction insures all stress borne by the blank-holder slide being taken up by the press frame.

At the beginning of the stroke, the blank-holder slide first moves down, while the punch slide first moves upward a trifle, and then downward with the blank-holder slide, but somewhat behind it. When the blank-holder slide dwells the punch slide continues its downward movement, and forces the blank into the die, causing it to slip between the lower side of the blank holder and the upper face of the die, under a uniform and even holding pressure. The punch slide then moves upward together with the blank-holder slide, and the drawn and stamped shell is pushed out of and to the top of the die, by means of a knockout actuated by the blank-holder slide.

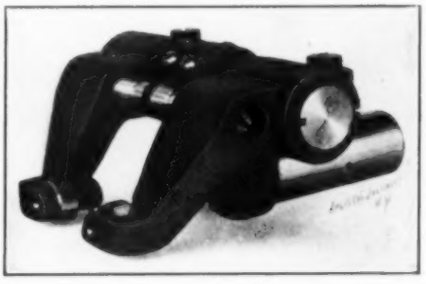
The press shown will receive and handle a 42x23-inch blank of No. 14 gage steel, or smaller blanks of heavier stock in proportion. It will take a drawing punch 12x36½ inches. The press makes 30 strokes per minute and weighs approximately 42,000 pounds.



DOUBLE-CRANK TOGGLE DRAWING PRESS

A New Nurl Holder

Something of a novelty in the way of a nurl holder is shown with this. It consists of a shank for the turret, 1 or 1¼ inches in diameter and having a ¾-inch hole through it for long stock. The arms are carried on a cross bar on which they can be adjusted at will to suit different diameters of work, being moved by the right and left screw shown. The nurls are held on hardened-steel pins, which are held in place by a spring fitting into a notch in the pin, and are made reversible so as to secure double wear.



A NEW NURL HOLDER

This construction gets the tool out of the way, leaves the cross slide free for cutting-off or other tools and the heavy arms support the work admirably from each side. It will nurl anything from zero up to 2½ inches in diameter. It is made by the Graham Manufacturing Company, Providence, R. I.

Two-speed "Rapid Action" Planer

The accompanying engravings illustrate a planer built by the Mark Flather Planer Company, Nashua, N. H., in which machine is incorporated a new shipping mechanism and in connection with it a two-speed mechanism in the planer bed, both of which have been designed with a view to utility and convenience of operation. The general arrangement of the exterior driving mechanism is shown in Fig. 1 and details of the gearing are presented in Fig. 2.

The driving mechanism is operated through two trains of gears on the first, or pulley shaft *A*, Fig. 2, and on the second, or intermediate shaft *B*, and the change of cutting speed is made by sliding the gears *C* on the second shaft into either one of the gears *D E*, on the first shaft as may be required. The position of the sliding gears *C*, is changed by means of a rack connected to a yoke which fits in a groove cut in the hub of the sliding gears. This rack is operated by a gear on the end of a shaft which in Fig. 1 is shown parallel to the housing, and projecting a sufficient distance back of the housing so that a lever may be used to operate it. The second shaft *B* has, as shown, a gear on the inner end, inside of the bed, for driving the third and fourth shafts in the manner in which the Flather planers are regularly driven. The return is accomplished by another train of gears entirely independent of those on the first and second shafts previously mentioned.

A long quill *F* which forms a bearing for the pulley shaft, is fitted into the bed, forming on the part projecting from the housing, a bearing for two of the four pulleys necessary for the drive. The drive is made up of two extra wide loose pulleys with heavy rims, and two of the regular

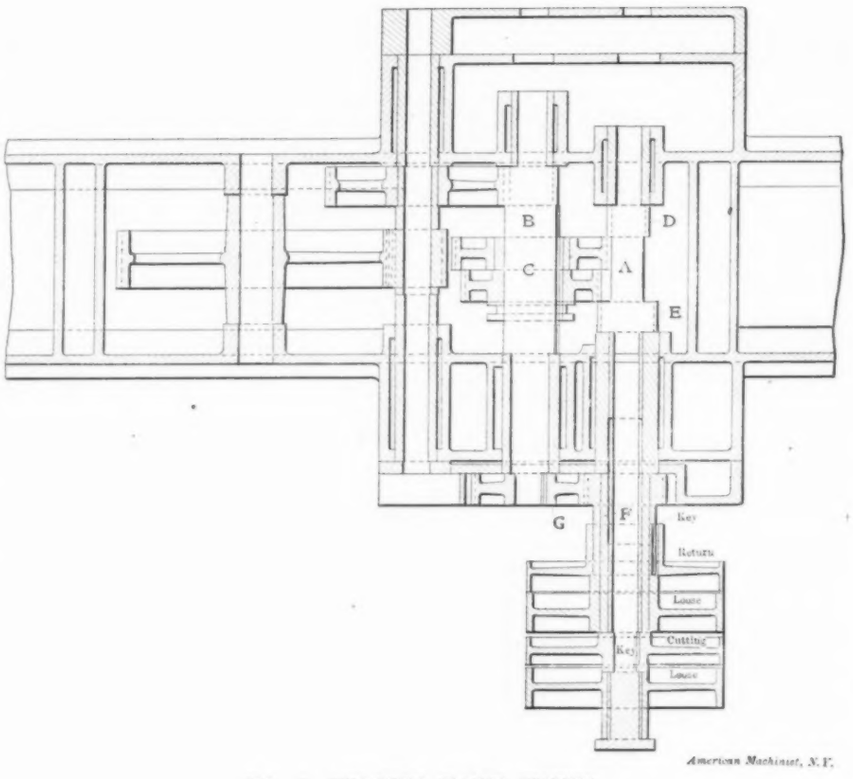


FIG. 2. TWO-SPEED PLANER GEARING

width with very light rims. The pulley next to the housing has a gear on the hub and revolves loosely on the extension of the quill *F*. This gear meshes into a gear *G* on the outer end of second shaft, and the ratio of the gears is such as to secure a quick return speed without having to use excessively large or small pulleys on the countershaft, or on the pulley shaft on the planer. All pulleys on the pulley shaft are of the same diameter, and there is only a small difference in the diameters of the pulleys on the countershaft, as such variations in speed as it is desirable to obtain are secured by the gearing.

The second pulley from the housing is a loose pulley with a heavy rim and also has a bearing on the long quill referred to. This quill forms a stationary bearing for these two pulleys, thereby eliminating excessive wear, heat and friction caused by pulleys revolving in one direction and the shaft in another at a high rate of speed. The third pulley in this series is keyed to the end of the first shaft and

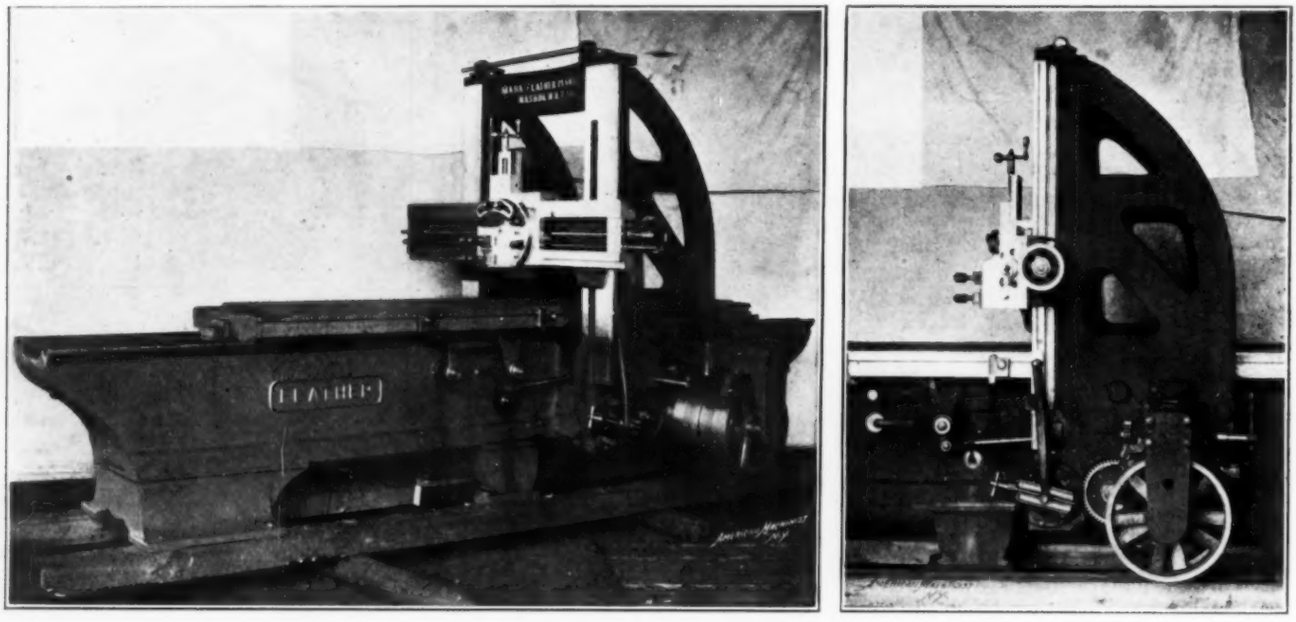


FIG. 1. TWO-SPEED "RAPID ACTION" PLANER

drives the planer while cutting. This is the only pulley which has any bearing on, or is in any way attached to, the driving shaft.

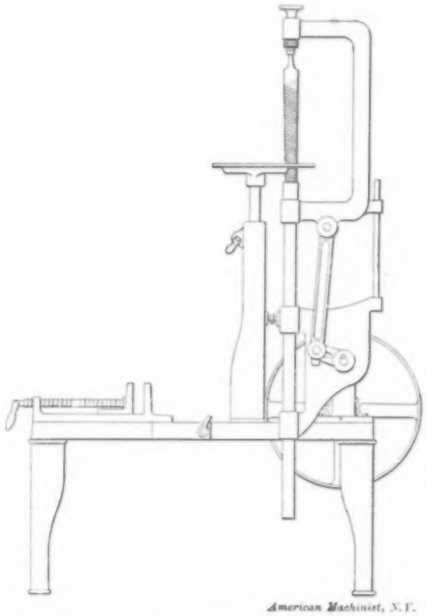
The fourth pulley is a heavy-rimmed loose pulley which revolves on a stationary bearing which is formed by bolting a casting to the outer end of the main part of the belt shipper casting with a projecting hub in line with the pulley shaft. This hub forms a bearing for the outer loose pulley entirely independent of the shaft.

The tight pulleys are made of the regular width ordinarily used, which on the size planer shown (30-inch) is for a 2-inch belt. The loose pulleys are much wider and with a thick rim, for the purpose of acting as balance wheels. For driving the planer belts are used about 25 per cent. wider than usual, and are only shipped on to the tight pulleys to the normal width, leaving part of the belt on the heavy loose pulley which acts as a balance wheel, to assist in reversing the planer, also in carrying the cut through when any high spots or hard spots are struck in the work being planed. The tight pulleys are made as thin and as light as possible, and only one being on the shaft it reverses very easily owing to the fact that there is little momentum to be overcome. On this type of planer the rotary cam has been adopted as being easier to operate and quicker acting than the plate cams formerly used by the company.

The planer illustrated was arranged for operation with cutting speeds of 26 feet and 45 feet per minute, with a return speed of 120 feet per minute, this return rate being constant. The machine was driven by light, double belts, 2¾ inches wide, and reversed quickly, without jar, and without loss of time at either end of the stroke.

Filing Attachment for Power Saw

This is a novel attachment made to be used in connection with the power saw manufactured by the Robertson Drill and Tool Company, Buffalo, N. Y. The only attachment necessary is the upright, fastened to the saw bed and the table which it supports. The hack saw is replaced by a file and the saw frame turned up in the air around its driving shaft. It can be adjusted to file at exact right angles or any desired degree of clearance in the case of dies. The attachment can be put in place at any time.



POWER SAW WITH FILING ATTACHMENT

The Lyon System of Steel Racks

Steel racks have ceased to be a novelty, but they too often have the appearance of having just happened instead of being designed in a systematic way. This is particularly true of home-made racks. In this case there has been a systematic following of a definite plan in which strength is the first consideration, but the weight is kept as low as consistent. The general construction can be seen from Fig. 1, in which the upright partitions are reinforced by face strips, these partitions being fastened together by tie rods which support the standard shelf. A modification of this, showing a method of enlarging the capacity of the shelves, or of converting them into bins, is shown in Fig. 2. This consists of partitions attached to the facing strips of the rack already in position by means of clips bolted through the rod holes. Shelves are then inserted in line with the shelving to make it all continuous. These admit of standard bin attachments the same as regular bin racks.

The bin-shelf attachment, shown in Fig. 3, is easily adjusted into place, and Fig. 4 shows how the angle plate at the end is secured and is adjustable. This front is fastened at each end, but also locks all the way along the front as can be seen. This not only tends to prevent bulging, but also stiffens the shelf at the front edge of the shelf to resist vertical loads.

Special rod connections allow compact and rigid connections without bolt heads to take up room or to be in the way. Box stops, consisting of light channel irons, can be fastened to the shelves to prevent boxes being pushed in too far and to preserve alinement. Then there are removable partitions which allow smaller divisions to be made at will. They are made the same depth as the shelves and are

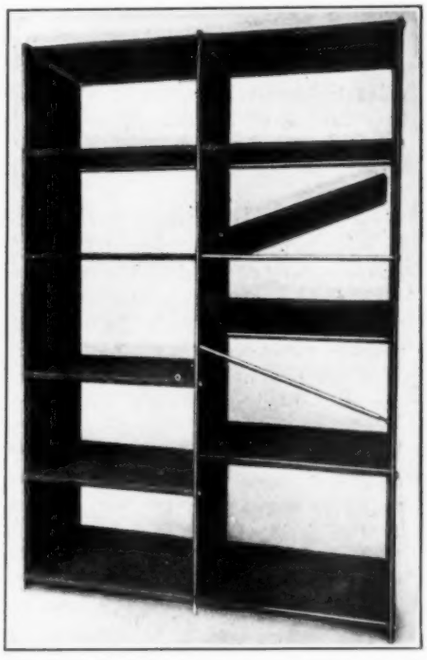


FIG. 1. CONSTRUCTION OF SHELVES

FIG. 2. RACKS WITH EXTENSION

FIG. 3. BIN FRONT FOR SHELVES

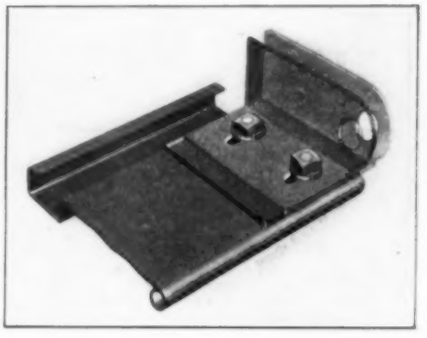


FIG. 4. FASTENING OF BIN FRONT

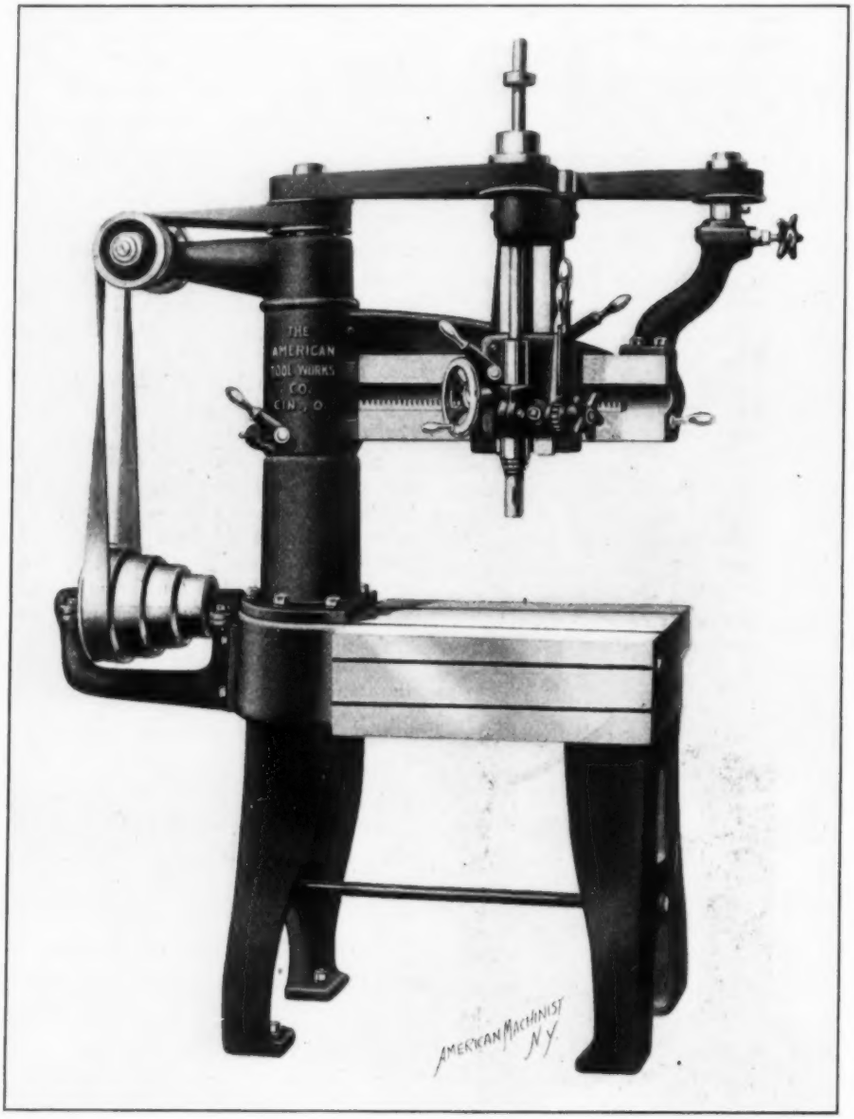
made to fit into different shelf spacings. Backs can be attached to bins to prevent material falling through, and there are also bracket-shelf attachments which are extremely handy for resting boxes or for sorting material.

It is impossible to go into all the details of the system, but it has been carefully worked out to meet the requirements of the average shop. They are made by the Lyon Metallic Manufacturing Company, Aurora, Illinois.

High-speed Radial Drill

That more attention is being paid to proper drilling conditions is evidenced by some of the newer types of drilling machine, among them the sensitive radial drill shown herewith and made by the American Tool Works, Cincinnati, O. This gives spindle speeds of from 300 to 900 revolutions per minute, which are in line with the higher speeds that are demanded in modern shops. The operation can be easily seen, the belt drive being kept taut by the adjustable idler at the outer end of the radial arm, which is built in both 2- and 3-foot lengths.

The field for such a machine is larger than may seem apparent to those who have not made a special study of their drilling operations. The regular radial is too heavy and too expensive to use on a lot of small drilling that can be handled more economically on a tool of this size, where high speeds can be obtained without undue wear on a train of gearing. In fact a pair of bevels at the base of the column are the only gears in the driving mechanism. Ball bearings of a special design are used in all pulleys. The arm is a combination of a tube section and a parabolic beam to resist the thrust of the drills.



SENSITIVE RADIAL DRILL

While heavy drilling is not expected on a machine of this kind it is interesting to note its capacity, as shown in a test, with a ¾-inch drill at 375 revolutions per minute, or a cutting speed of 73.7 feet per minute. This was fed into a block of cast iron at the rate of 10½ inches a minute, or 0.028 inch per revolution and took 3¼ horsepower.

Motor-driven Vertical Spindle Milling Machine

The halftones illustrate a design of vertical milling machine recently developed by the Newton Machine Tool Works, Philadelphia, Penn. As will be noted, the spindle is driven by a sleeve worm wheel. The front of the frame has a finished surface for convenience in setting work and also to support a bearing for the lower end of the spindle. The movements are all controlled by clutches, the feeds have nine changes through gears, and there is provided fast traverse for all movements. The spindle is 5 inches in diameter and revolves in a straight brass-bushed capped bearing 22 inches in length over all. The spindle is mounted in a saddle having square lock bearings on the upright, side adjustments being maintained by means of brass taper shoes. The saddle is counterweighted and has fast and slow vertical adjustments by hand from a minimum distance from the bottom of the spindle to the top of the circular work table of ½ inch to a maximum distance of 22 inches. The spindle is driven by a steep lead bronze worm wheel and hardened steel worm (both incased and arranged for continual lubrication) through intermediate gears by a 15-horsepower 2 to 1 General Electric C. R. 10B frame motor.

As shown in Fig. 1, the drive from the motor is transmitted through a rawhide pinion to a horizontal shaft on which are mounted spur gears engaging the clutch gears on a second horizontal shaft, having a ratio of 2 to 1, and giving a speed range to the milling spindle of 17.22 to 34.44 revolutions per minute in the low gear and 40.18 to 80.37 revolutions per minute with the high gear. The feed motion is transmitted through the feed box to the tumbler gears by which reverse motion is obtained for the fast traverse and the feeds; motion for the fast traverse being obtained by the engagement of a friction clutch operated by a hand lever at the side. With the high-speed gears in mesh, feeds from 0.0052 to 0.0546 inch per revolution of spindle and with the slow-speed gears feeds from 0.21 to 0.1274 inch per revolution of spindle are obtained, across and in and out, and circular feeds from 0.0002 to 0.0064 inch, and 0.0023 to 0.0706 inch are obtained on a 10-inch circle. With the slow-speed gears in mesh feeds of 0.0005 to 0.0148 inch and from 0.005 to 0.165 inch per revolution of spindle are obtained on a 10-inch circle.

The circular table is 42 inches in diameter over the T-slots and is surrounded by a reservoir giving an over-all diameter

of 48½ inches. The circular table has a central bush bearing in the saddle 8 inches in diameter, has an over-all surface bearing 37 inches in diameter, and is held securely against this bottom bearing by corner clamps. The worm wheel by which the table is rotated is made of bronze; the cross-slide adjustments are obtained with taper brass shoes. The cross-saddle has square lock bearings on the frame, adjustments being likewise made by means of brass taper shoes. These tables are arranged with races for conveying the surplus lubricant from the top table, through the saddle and cross-slides to the frame, from which it is returned to the storage tank shown on the side of the machine in Fig. 1, to be returned by the pump shown. The cutters are screwed onto the outside of the spindle or fitted to the No. 6 Morse taper provided, and it is intended that these cutters should be driven by a broad face key. The work table has a No. 4 Newton taper to accommodate mandrels for the location of work. The machine is of heavy construction and designed to drive the modern high-speed cutters to their maximum efficiency. All levers controlling the operations have been concentrated to facilitate an increased production. The machine occupies a floor space of about 4x10 feet. Work 20 inches in hight can be placed under the end of the vertical spindle. The distance from the center of the spindle to the front of the frame is 33 inches. The length of in-and-out feed is 33 inches; length of cross-feed, 33 inches.

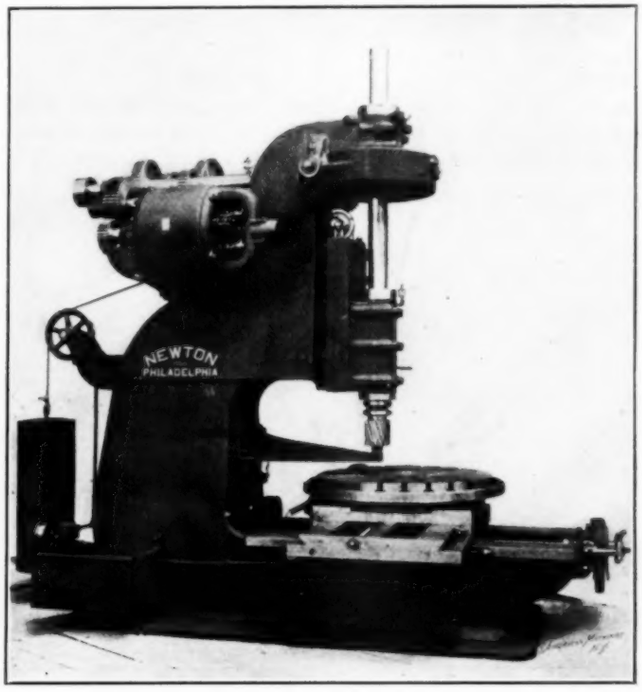


FIG. 1

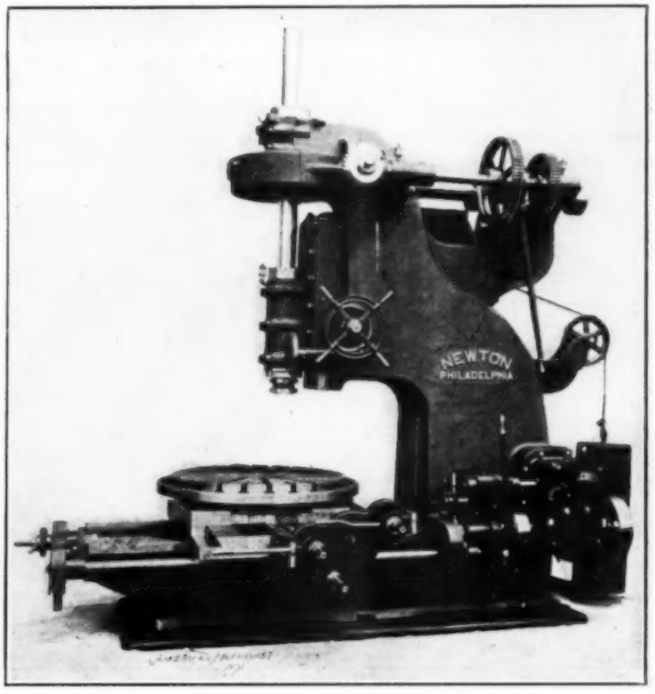


FIG. 2

VERTICAL SPINDLE MILLING MACHINE

The Right Tool Steel in the Right Place

By J. Davy

This, of course, is a very broad subject, and we can only touch on it lightly. During the last few weeks I received a copy of a letter sent out by one of the largest steel manufacturers in the country. This letter was so adverse to what I had looked for that it was almost disgusting. When I first read it I was tempted to throw it in the waste basket, but my sympathy for the poor steel man was such that I could not treat their efforts to help their patrons in this manner.

The information conveyed in their letter was: First, the question, How do you drill very hard and tough material, such as nickel steel or armor plate? The reply was as follows: "I am in receipt of your inquiry in regard to drilling armor plate without annealing and will say that we use ordinary flat drills, made of our best grade of carbon steel (carbon contents recommended 1.15 to 1.35 per cent.) These we harden in salt water and do not draw the temper. We use turpentine to lubricate the drill."

Now, what do you think of the reply, and what would you think if I told you that this company was manufacturing armor plate and that they were also employing between fifteen and twenty thousand men in the manufacturing of steels, etc.? Will the time ever come when the right steel will be in the right place, and who is going to put it there?

Importance of Question

This is a question of vital importance to the users of tool steel, as well as all kinds of steel. I have seen steel used that cost 18 cents per pound, whereas if a grade of steel had been used that could be had for 4 cents a pound the results would have been entirely satisfactory instead of a failure.

I have also seen expensive tools made of an extremely poor grade of steel with the result that the tools would not do the work after they were completed. This has happened where steels of different grades were in the rack at the convenience of the toolmakers, with, of course, the usual regulations of having an order or two from the foreman.

I have seen springs made of steel so extremely low in carbon that it would be impossible to harden them in the regular way. If there had been an abundance of steel suitable for springs in the steel rack I would have no fault to find, as then it would be, do the best that can be done.

In the general large manufacturing plants in which I have been employed there is but one who is following out the idea of having the right steel in the right place. Of course, it is done by all to a moderate degree, but it is sorely neglected by most all.

Instructions From Salesmen

The steel mills have been making a steel

for nearly every purpose, yet it has not gotten into the right place, as will be seen by the letter given above. Let me assure the reader that this mill does and has been for some time manufacturing a steel that is especially adapted to the cutting of tough and hard material. It is true, of course, they have some steel that they think will do most any kind of work, but they do not seem to know it and, therefore, ask the manufacturer to try it. There should be no reason why they do not know what steel should be used, how it should be used, how is should be hardened, how it should be ground and how much speed it should cut at.

My reason for enumerating the above is that I have seen excellent steel sent into a shop and the entire lot condemned, not because there was anything materially wrong with the steel but simply from lack of information on these points. The steel was treated in the ordinary manner, with extreme care, but when it came to using the tool it was worthless.

I have seen the representative of a steel company come into a shop and undertake to handle their steel when he knew no more of the correct method of handling and working it than the apprentice boy. I at one time had a steel representative tell me that dies for drop hammers should be made of steel from 1.10 to 1.25 per cent. carbon. At another time one of them said that the way they annealed their alloyed water-hardening steel was by heating it to a cherry red and burying the steel in ashes. I have cited this incident, including the letter, to give the reader an idea of about the average result obtained by inquiry made in reference to the product that the steel representative is selling.

High-speed Steel

It is true that they recommend a given carbon for hammer dies, milling cutters, etc., but when we take up some of the later alloyed steels how do we find them? I have seen them try to machine steel with high-speed steel that carbon steel had been tried on and would not even make an impression and then go away leaving the foreman in a helpless condition, whereas, if they had put the right steel in the right place and under the proper speed, they would have increased their company's standing as well as their business.

I have seen most every kind of high-speed steel tried in most every conceivable kind of a tool, and while some success was obtained in a part of the tools, yet it was a waste of money to try high-speed steel in some of the tests. And again I have seen failures that were due entirely to the speed at which the tool was run.

Failures and Remedies

A failure is sometimes due to the steel being heated in the grinding. (This may be questioned, but try your alloyed water-hardening tools after grinding.) As a result the steel may be condemned. The reason will not be because it was not as good as what was in use, but because it was not in the right place. It will be found, in working hard and tough material such as armor plate, that high-speed steel is worthless. Common carbon steel, carefully forged to a flat drill, then heated carefully and cooled in mercury or brine, will be of much more value than high-speed steel.

Then there is a grade of steel known as alloyed water-hardening steel, or a steel for finishing cuts, that is of much more value than the common carbon steel. This steel is easily forged, hard to anneal for machining without packing, is easily hardened, and it requires no tempering after hardening except to relieve the strain. It is extremely sensitive to heat after being hardened and great care must be used in the selection of an emery wheel to grind this steel on or the tool will be ruined, no matter how small a cut is taken or how much water is used.

The speed of this tool is also very important. It is, as I have said, very sensitive to heat consequently it must be run at a slow speed. If a finishing scrape reamer is to be made, on which there is but a few thousandths to be removed, and a fine finish is desired, then the steel to use is the alloyed water-hardening steel. In fact there are many places where this steel could be used where the results obtained would more than pay the difference in the price of the steel.

I, at one time, saw a machinist try to start the turnbuckle on the rim of an automobile wheel and he at last gave up and thought that he would have to cut it in two. I suggested a trial of a pin made of alloyed water-hardening steel, with the result that he was able to remove it after he had hardened and tempered the pin.

Press Tools for Making Hollow Handles for Cooking Utensils

By Julius F. A. Vogt

The accompanying sketches show a set of dies for making hollow handles of sheet iron for granite cooking utensils. The handle is shown at the right in Fig. 1, which illustrates the various steps in the forming process. The material used in the handles is No. 26 gage sheet-steel scrap. There is generally a great deal of it, and it can be used for such handles to advantage.

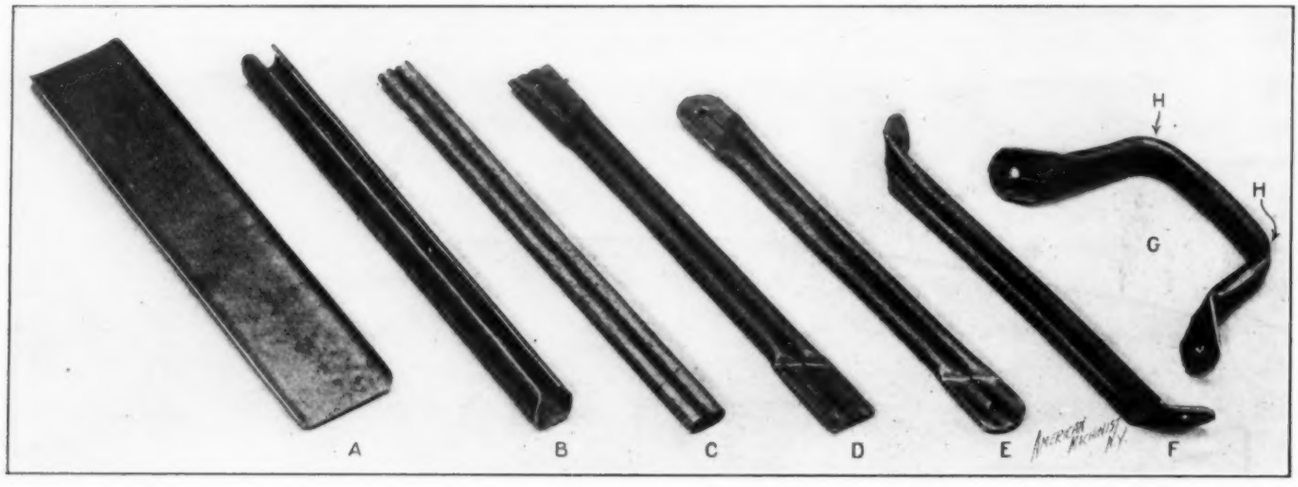


FIG. 1. EVOLUTION OF A HOLLOW HANDLE FOR COOKING UTENSILS

Fig. 2 shows the blanking die and punch. Fig. 3 is a cross-sectional view of the first operation forming die and punch. The die in Fig. 3 consists of the wrought-iron die block *a* with the tool-steel forming part *b* welded onto it, and the pad *c* supported by a steel spring not shown in the sketch. The punch consists of the machine-steel shank *d*, to which the tool-steel forming part *e* is fastened by means of screws and dowel pins.

The operation of the die is as follows: The blank is put into the gage *f f* and rests on the pad *c*. The punch in coming down clamps the blank between its face and the

face of the pad and carries it into the die, forming it into the shape shown at *A*, Fig. 1. It is absolutely necessary to give the forming part of the die the proper curve, so that when the blank is curled the edges of the curled part may stand at right angles with the back of the handle to prevent it from kinking in the last bending operation.

Fig. 4 shows the second operation forming die and its punch. The steel forming part of this die is welded to a wrought-iron die block. The forming part of the die is provided with three spring pins *g*, only one of which is shown in the sketch. In operation the partly formed blank, shown at *A*, Fig. 1, is put between the gage lips *h i*. The punch in coming down clamps the blank between its face and the spring pins, and carries it into the groove of the die. Both sides of the blank which were curved in the first operation bend around the punch which is grooved above to receive the edges of the blank. When the punch ascends it carries the partly formed handle up with it. The handle hangs on the punch and can easily be stripped off. This operation changes the shape of the handle to that shown at *B*, Fig. 1.

Fig. 5 is the third operation, forming or curling die and punch. The partly formed handle *B*, Fig. 1, is placed in the die, and the punch in coming down curls the sides, as shown in Fig. 1 at *C*. The next operation is to flatten the ends of the handle. This is done with the die and punch, Fig. 6. The curled piece *C* is put between the gages *a b*, as represented. *D*, Fig. 1, shows the handle after flattening at the ends.

Fig. 7 is the punch and die for trimming both ends and punching both rivet holes at the same time. At *a* and *b* are the trimming and punching dies proper; *c* and *d* are strippers; *e* is the back gage. In operating the die, the handle, as shown at *D*, Fig. 1, is placed against the back gage *e* and the end gage *f*. The punch then trims both ends and punches the two rivet holes as at *E*, Fig. 1. The handle is stripped from the piercing punches by means of the strippers *c* and *d*.

Fig. 8 is the end-bending die and punch. The handle which was trimmed in the former operation, is now put into the gage *a a* of the die, Fig. 8. The corners *b* and *d* act as side stops. The punch in performing its work bends both ends of the handle at an angle of about 45 degrees, as shown at *F*, Fig. 1. It may seem that this operation and that of the finishing die should have been combined, but this would not work.

The finishing or bending tools are seen in Fig. 9. The forming part *a* of the die is machined at *b* and *c* to the inside size of the handle. The recess shown by the dotted line *e f* is milled into it to receive the handle. The pad *g* is guided by the two pins *h h* and held up by the strong spring *i*. It is also recessed at the top, as indicated by the dotted line, so that the handle fits loosely in it. The punch is fitted closely between *b* and *c*, and recessed slightly as represented by dotted lines. The handle in the form shown at *F*, Fig. 1, is placed in the groove of the pad *g* and gaged endways by the corners *k k* of the die. As the punch descends it clamps the handle loosely between its face and the pad, and carries it into the die, bending it to the shape shown at *G*, Fig. 1. It will be seen that the die and punch have only to make two bends, *H H*, Fig. 1.

This method of making hollow handles can be used with slight modifications as to size and shape of tools, for tea- and coffee-pot handles also. There are eight operations in all on the handles, but they are not slow and tedious, and as the material costs but very little, they are cheap at any rate.

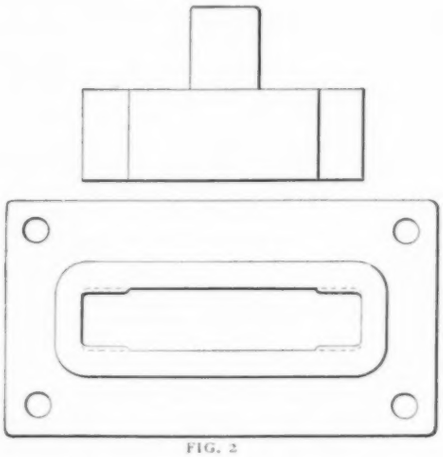


FIG. 2

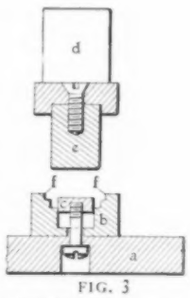


FIG. 3
For Operation A, Fig. 1

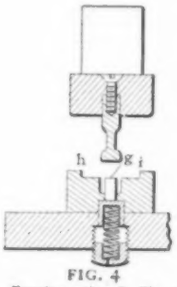


FIG. 4
For Operation B, Fig. 1

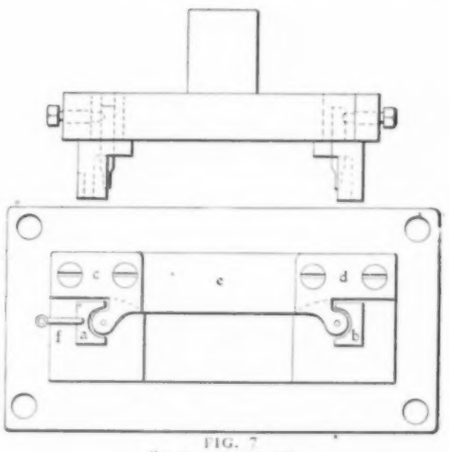


FIG. 7
For Operation E, Fig. 1

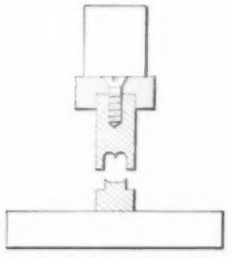


FIG. 5 - For Operation C, Fig. 1

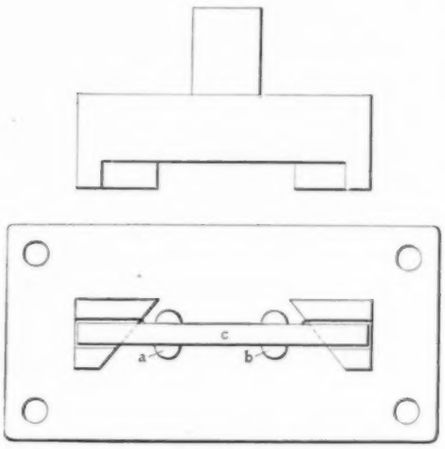


FIG. 6
For Operation D, Fig. 1

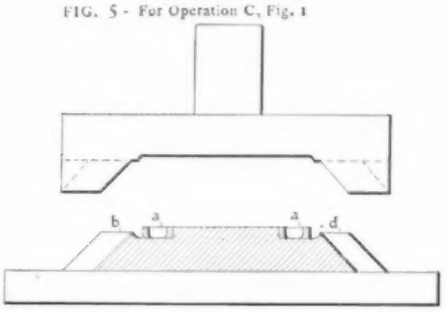


FIG. 8
For Operation F, Fig. 1

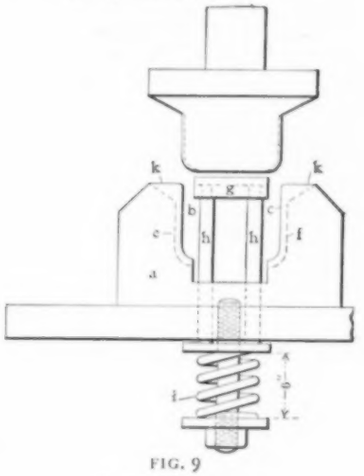


FIG. 9
For Operation G, Fig. 1

American Machinist, N.Y.

PRESS TOOLS FOR HOLLOW HANDLES FOR COOKING UTENSILS

Engineering Meeting on Conservation of Our Natural Resources

On the evening of March 24 a meeting of the engineering profession was held in the auditorium of the Engineering Societies building, participated in by the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers.

There were four speakers. The prominent thought brought out by three of them—though from different fields of engineering endeavor—was gratification for the arousing of general interest in natural-resource conservation, but regret that many of the popularly accepted statements are not based on truth and fact. Before a successful solution of these problems is reached, underlying data must be collected and digested; proper action cannot result from incorrect hypotheses and unsupported premises. Much of the present agitation is artificial; another part is erroneous and still another is premature.

In opening the meeting, the presiding officer laid stress upon the fact that engineers have been actively employed in conservation work for the past two generations. The use of stoves for blast furnaces is now saving 40,000,000 tons of coal per annum from the amount that would be burned if such furnaces were still operated as they were before the heating stoves were developed. The use of bessemer converters in the manufacture of steel in this country is now saving 50,000,000 tons of coal per annum of the amount that would be burned if steel was still made in puddling furnaces. Cut-off engine valves and multiple-expansion engines are saving from 30,000,000 to 40,000,000 tons of coal per annum of the consumption that would be required to generate our present requirements in steam power with slide-valve engines. All of these devices, developed by engineers, are conserving our coal supply.

John R. Freeman addressed the meeting on the subject, "The Conservation of Water." He said that a careful investigation of steam-flow records of the Merrimac and Hudson rivers had failed to show any perceptible change in their flow due to the lumbering operations along their watersheds for the last 100 years. Probably there is no other river in the United States concerning which there are such complete and accurate flowage records as exist in regard to the Merrimac. These facts are strongly opposed to the commonly accepted opinion that the deforestization of any section has a marked and detrimental influence on the flow of the tributary streams.

Mr. Freeman offered several suggestions among which are: Burn all tree tops after lumbering operations. Fire is more to be dreaded as a destroyer of forest humus than deforestization. Watch and record the flow of all important streams in a more careful manner than such work is done at present. Better have such work done intensively rather than extensively, and thus provide data that will be of real service. Work for an increased annual appropriation from Congress for the hydrographic office to be devoted to the study and investigation of streams, waterpowers, and the like; in order that there may be built up a fund of accurate information from which correct conclusions may be drawn.

The conservation of our natural resources by legislation was the subject of an address by R. W. Raymond. This address was presented partly as a printed paper and partly extemporaneously. He deplored much of the conservation legislation of the past and urged upon the engineering profession the necessity of guiding the popular interest that is now active and the legislation that will inevitably follow. A section of New York State's constitution prohibits the cutting of timber on the State Forest Reserve. This provision has put New York behind all other States in intelligent forestry. We quote, "I say 'at the tail,' but perhaps it would be more accurate to say that New York is out of the procession altogether; for I do not think that any other State, however backward in popular intelligence, has ever gone quite so far as to forbid forestry upon its public land." In regard to the purchase of a given section of Government mineral land, the situation of existing laws is: "We (the Government) do not know whether we own it or not, but you can have it surveyed if you like and then advertise for 90 days your desire to purchase it, and if nobody appears within that period to oppose your claim, we will conclude that we own the land and will sell it to you."

"The Waste of Our Natural Resources by Fire," was the subject of an address by Charles Whiting Baker. He gave the fire loss in the United States for 1907 as $215,000,000, one-half on buildings and the other half on contents. Furthermore, 1450 lives were lost and 5650 persons injured at these fires. He made a plea for action to reduce such an enormous waste; a waste out of all proportion per capita to similar losses in European countries.

The closing address was, by Lewis B. Stillwell, "Electricity and the Conservation of Energy." Were the energy now generated at Niagara by water generated by the consumption of coal, 1,000,000 tons per annum would be required. Thus coal is conserved by water-power development. Today some 25,000,000 horsepower are used in American industries excluding steam railways. Of this amount 5,000,000 horsepower are generated by water and 850,000 horsepower from gas, leaving roughly 20,000,000 horsepower generated by the combustion of coal. From somewhat questionable sources it is estimated that there are 37,000,000 horsepower of water powers that could be developed to give power for the present cost of steam power. The Government should take steps to investigate all water powers and inland transportation facilities. The proposed scheme to tax water powers for the benefit of inland waterways is open to most serious objections. It should be pointed out that the cost of canal transportation is not and may not be so much less expensive than railway transportation—popular impression to the contrary.

Use of Oxy-Acetylene Torch when Drilling Hard Spots in Cast Iron

By A. Newton Hammond

An occurrence of more than usual interest happened a few days ago. Evidently some hard metal, the specific gravity of which was more than cast iron, found its way into a housing in which we wanted to drill a 1-inch hole through metal 1¼ inches thick. High-speed drills would not touch the same, nor did any changes in speed, nor any of the kinks, seem to have the desired effect. Fortunately, however, the piece of foreign matter was small and small holes could be worried through on a tangent.

After all the cast iron was removed that could be drilled out from both sides, muriatic acid was tried but did not seem to have much effect on the objectionable interloper. Sulphur and molasses was also tried with the same result.

Next I brought out the oxy-acetylene torch and was laughed at for my pains, but I think that the master mechanic, foreman, or one in any other position that cannot make a go under existing conditions ought to step down and out. The question was whether we would make the housing locally hot or not, and I left confident that this was not only possible but required no great skill. The gas torch therefore was applied and the results were very satisfactory.

Now one question I want to ask is: Is it possible to run a small drill too slowly to cut very hard steel?

My personal experience has been that too slow is as hard, or harder, on the drill than too fast. Anyone will know that they have often wished that they could speed up the ratchet a little on a ratchet drill, especially on drills from ⅛ to 5/16 inch, or even to ⅜ inch. Also in drilling bed plates for beaters used in paper mills 9/16-inch holes at the slowest speed was too slow and the increase of one step of the cone made it do 1½ times more work and was far easier on the drill.

The One Man Shop

By Entropy

Every machinist that has a spark of ambition has at some time felt the call of the business world. Sometimes he staves it off, sometimes he goes into business with some of his shop mates for partners and sometimes he buys into the concern for which he is working. The ideal thing though was what my friend John D. did. John did not have much money saved up, but he had a little 10-inch screw-cutting foot lathe at home and a few tools. He got up a new and improved surface gage which, between you and me, was no better than lots of others. He sold two or three of them around the shops where he worked and he most naturally contracted the disease. He was just selfish enough to want all there was in it so he worked like a trooper nights and Saturday afternoons and possibly other times getting out a few. When he got half a dozen he took a day off and went over to V. to see if he could place them in the hardware stores. They all wanted prices in dozen lots and when he let it leak out at the first store that he was making them at home and had only half a dozen on hand they laughed him out of the store. Wiser, he took an order for a dozen at the next store for delivery the next week, by claiming that he was ordered up ahead.

When he was at home that night he found it hard to decide what to do. He did not want to drop his job which was a sure thing, did not want to share profits with anyone, and knew that at the price he took his order, that he could not get any shop in town to fill it, and he also knew that he could not expect to secure orders if he raised his price much. The rest of that dozen he made up in time that surprised him. He had something to work for that seemed worth while. As he worked he thought how much time he could save by a little jig to drill some holes, and how he could better buy drill rod or straightened wire and polish it or lap it to size than try to turn the limber stuff. How much more he could do if he had a little electric motor to take the place of already tired legs, and how a little drill would help. After that first dozen was delivered he used what little money and credit he had for those things. Then he got bids on some of the parts from some people who had screw machines and finally he found himself doing quite a business fitting together parts which other people made for him. Things looked pretty good until the evil day came when the shop where he worked went on short time and he decided to buy another lathe and some more tools and hire one of his old shop associates to work for him. Just about the time John had his new shop fitted up, and got started he began to find that orders were coming slow. To occupy himself and his new man Friday he started in again to make all the parts himself. Not having a screw machine and his new man having no more ambition than he had when he worked for someone else it cost more for these parts than it did before. Added to this was the rent of the room. John kept it up in the vague hope of more orders until his money was all gone and then he very wisely quit, which he could not so easily have done if he had gone ahead on credit. Often poor credit is a mighty good asset for a man to have. He went back to the house with his machinery, sold his larger lathe and hunted up a short-time job that gave him his bread and butter. There was no sale for his surface gages except in driblets but he kept piling them up. He could afford to, for his material cost little and his power not a great deal. He was making all his parts except a few that cost less outside. For those he made gages, a set to send out and another set to test by. When things began to pick up he had a lot of work and a little money tied up in partly finished gages. Then he made mistake number two. He cut prices to get rid of the stuff. While it was going he apparently made money hand over fist because he was really getting his back pay for work already done.

After his accumulated stock was gone he found that business in general being better he had to pay more for materials and more for his parts, which he again wanted to have made for him by his friend with the screw machine. He also found when he went out to sell his gages again that his old price had become a basis of value in the eyes of his trade, and while they conceded him the right to advance his price they did not think that he should advance it so much as he had to to make a decent living. They figured that other manufacturers were advancing 10 per cent., and he 20 per cent. Vainly he tried to show them that his 20 per cent. was from a temporarily reduced price and was only 10 per cent. over his original price. He finally gave it up and took orders at his original price, and went home and nearly sweated to death filling them, while up at the old shop they cut the hours to 8 a day and kept the pay the same.

About this time he began to size himself up, with a little help from his wife, as several kinds of a fool. His pride was too great to allow of his giving up altogether. He got up an "improved" surface gage which was not quite as good as the old one for the usual run of work, but which had devices about it that substantially removed the need of a tool room for any ordinary shop. Of course, while it was being used for a jack for leveling up a casting it could not be used to see if it was level, but that could be easily gotten around if the purchaser bought two. This time John had learned a trick or two. He did not begin to sell until he had given a few away to all kinds of workmen and found out what they thought about them. Then he did not begin to sell either. He just built his jigs and then built a lot of gages. When he knew just how fast he could build them he went out with a price marked on them that would give him a whole raft of profit. The dealers said:

"We have no doubt your gages are worth the money, but our customers have never been in the habit of paying so much for a tool by that name and we don't believe they will."

John got them to take a dozen on consignment. Then he made a bee line for the largest shop where such tools were used and found Cousin Bob. He talked with Cousin Bob for an hour and left him with 10 one-dollar bills. In a day or two Mr. Dealer began to have calls for John's surface gages, no substitutes would go and the price seemed to be no object. Each man that bought went straight to Bob and showed his gage and got a dollar. The dealer laid in a stock of surface gages. John knows better than to cut prices.

Forthcoming Meetings

Joint meeting of the four National Engineering Societies, Engineering Societies building, New York City. Conferring of the John Fritz medal upon Charles F. Porter.

National Metal Trades Association, annual meeting, April 14-15, New York City, headquarters Hotel Astor.

American Society Mechanical Engineers, semi-annual meeting, Washington, D. C., May 4-7.

American Supply and Machinery Manufacturers Association, joint convention with Southern Supply and Machinery Manufacturers Association, Chattanooga, Tenn., May 5, 6, 7; headquarters, Hotel Patten.

National Supply and Machinery Dealers Association and American Supply and Machinery Manufacturers Association, joint convention, Pittsburg, Penn., May 12-13-14, headquarters Fort Pitt hotel.

The Foundry and Manufacturers Supply Association, convention, Cincinnati, Ohio, week of May 17.

American Foundrymen's Association convention, Cincinnati, Ohio, May 18-20, headquarters Hotel Sinton.

American Hardware Manufacturers Association, joint convention with Northern Hardware Jobbers Association, Pittsburg, Penn., June 9-11, headquarters Hotel Schenley.

Railway Master Mechanics Association, annual convention, June 16-18, Atlantic City, N. J.

Master Car Builders Association, annual convention, June 21-23, Atlantic City, N. J.

Business Items

The Windsor Machine Company, Windsor, Vt., announces that its factory is running extra time four nights each week on account of the increasing demand for Gridley machines.

The Fairbanks Company has just opened a machine-tool department at its Pittsburg store and has put P. J. Westphall in charge. Mr. Westphall was formerly connected with the Builders' Iron Foundry, Providence, R. I.

The Modern Tool Company has purchased and moved to Erie, the tools, fixtures, patents, machinery, etc., of the Atlas Machine Tool Company, at Taunton, Mass., and the Modern Tool Company expects to have

both plain and universal grinders on the market very shortly.

Among the installations of the Roth Bros. & Company, through its New York office, are the following: Fourteen Roth type S. steel-frame motors in the plant of the Richter Furniture Company, New York City, and eight type S steel-frame motors in the plant of Crucet & Cooke Manufacturing Company, New York City.

Business Opportunities

The Terre Haute (Ind.) Motor Company is erecting a plant.

The Modern Machine Works, Portland, Ore. will enlarge plant.

The La Crosse (Wis) Plow Company is to erect a new foundry.

The Pittsburg (Penn.) Water Heater Company is building an addition.

J. W. Robinson, Rogers, Ark., will establish box factory and planing mill.

The Schelosky Table Company, Evansville, Ind., will erect a new factory.

The Wire Goods Company, Worcester, Mass., will erect a six-story addition.

The plant of the Fort Pitt Forge Company, Pittsburg, Penn., was burned.

A. C. Poole Auger Company, Scarbro, W. Va., will rebuild plant recently burned.

The Mayo Radiator Company, New Haven, Conn., is making plans for a new plant.

The United Iron Works Company will add a brass foundry to its plant at Iola, Mo.

The Standard Ground Key Works Company, Milwaukee, Wis., is to build a new foundry.

It is reported the Janesville (Wis.) Machine Company is to build a large addition to plant.

The Manitowoc (Wis.) Steam Boiler Works is contemplating an addition to plant, it is said.

The city of Barberton, Ohio, will purchase an air compressor for the municipal water plant.

The Lundin Steel Casting Company, Chelsea, Mass., is erecting a new steel foundry at Neponset.

The Oklahoma Iron Works, Tulsa, Okla., will erect new foundry building and structural iron shop.

The American Radiator Company is to erect a new plant to replace present one at Springfield, Ohio.

The Allis-Chalmers Company is planning for the erection of more buildings at its plant in West Allis, Wis.

The Belmont Stamping and Enameling Company, New Philadelphia, Ohio, will build an addition to plant.

C. A. Benjamin, Syracuse, N. Y., sales agent for several motor cars, is to establish a garage and machine shop.

Plant of the Empire Foundry Company, New Brunswick, N. J., was destroyed by fire. Loss, about $60,000.

The Western Crucible Steel Casting Company, Minneapolis, Minn., is preparing plans for enlargement of plant.

The Goodell-Pratt Company, Springfield, Mass., has purchased more land on which to build further additions to plant.

The Dominion Bridge Company, of Lachine, Que., is said to be having plans prepared for a steel plant at Winnipeg.

The Badger Brass Company, Kenosha, Wis., will build an addition to plant to be used for the manufacture of lamps.

The sash and door factory of the George Ainslie Company, Portland, Ore., was destroyed by fire. Loss about $50,000.

The foundry building at the plant of the El Reno (Okla.) Foundry and Machine Company was burned. It will be rebuilt.

The American Seeding Machine Company Richmond, Ind., it is said, is contemplating the erection of an addition to foundry.

The Martin Metal Manufacturing Company, Wichita, Kan., manufacturing metal ceilings, tanks, etc., will erect a new building.

The St. Louis & San Francisco Railway will erect roundhouse at West Tulsa, Okla., M. C. Byers, St. Louis, Mo., chief engineer.

The Cummings Machine Company, 238 William street, New York, would like to receive catalogs of machine tools and supplies.

The main building of the Easton (Penn.) Foundry and Machine Company was destroyed by fire, entailing a loss of nearly $100,000.

Fire destroyed the plant of the D. M. Dillon Boiler Works, Fitchburg, Mass., causing a loss of about $80,000. The plant will be rebuilt.

It is reported that the Kemp Machine and Foundry Company, Hattiesburg, Miss., will spend about $12,000 for improvements to plant.

The International Harvester Company, of Chicago and elsewhere, is said to be planning the erection of two manufacturing plants in Europe.

The Los Angeles (Cal.) Rotary Gas Engine Company is contemplating the erection of a factory to manufacture engine invented by T. L. Forbes.

The Cheshire Brass Mills at Mixville, Conn., were destroyed by fire, causing a loss of about $25,000. The plant was ow ed by J. O. Shares, New Haven.

The Rotary File and Machine Company, 589 Kent avenue, Brooklyn, N. Y., would like to receive proposals for equipment for machine shop to be run in connection with a mine as follows: 40-inch plain lathe, 3-foot radial drill, medium planer, 16-inch screw-cutting lathe with attachments, 20-inch upright drill, Saunders or Jarecki pipe machine, nut and bolt cutter, universal tool and cutter grinder. Communications should be addressed to N. B. Young.

New Incorporations

The Lynchburg Paper Box Company, Lynchburg, Va., incorporated to manufacture paper boxes. A. T. Ewing, president.

Excel Manufacturing Company, Boston, Mass., incorporated to manufacture and deal in all kinds of machinery. Capital, $25,000. J. J. Pratt, president.

The Napier Motor Company of America, Portland, Ore., has been incorporated with $1,000,000 to manufacture engines, motors, etc. H. B. Clarity, president.

The Bosworth & Damon Tool Co., Portland, Me., has been incorporated. Capital, $250,000. C. H. Burdin, president. Will manufacture and sell machines, tools, etc.

Electrical Sales Company, Boston, Mass., has been incorporated to manufacture electrical machinery of all kinds. Capital, $25,000. Francis A. Barbay, Cambridge, president.

The Peoria Sprocket and Chain Company, Peoria, Ill., incorporated to manufacture chain sprockets and chains. Capital, $10,000. Incorporators, W. B. Wilde, S. D. Porter, etc.

The American Valve Company, Boston, Mass., has been incorporated to manufacture and deal in all kinds of valves. Capital, $100,000. C. H. Tebbetts, Marshfield, president.

The Great Western Weigher Company, Peoria, Ill., has been incorporated to manufacture farm implements. Capital, $40,000. Incorporators. C. F. Clements, G. J. Jochem, W. R. Colman.

The Kauffman Kase Company, New York, incorporated with $250,000 capital to manufacture boxes, cases, crates, etc. Incorporators: J. T. McCarrier, L. B. Kauffmann, G. M. Nelson.

Elite Furniture Company, Jamestown, N. Y., has been incorporated to manufacture furniture and lumber. Capital, $25,000. Incorporators, G. A. Lawson, Chas. J. Anderson, Fred Swanson.

Emerson Engine Company, Alexandria, Va., has been incorporated for the purpose of buying, selling and manufacturing all kinds of engines. Capital, $100,000. Victor L. Emerson, president.

Modern Foundry and Machine Company, Paris, Ill., has been incorporated to manufacture in iron and steel. Capital, $100,000. Incorporators, R. M. Mason, P. A. Bowsher, B. R. Simmons.

Illinois Cutlery Company, 138 Jackson Boulevard, Chicago, Ill., incorporated to manufacture tools and cutlery. Capital, $10,000. Incorporators, Chas. Hans, F. W. Koenecke, Robert Krueger.

Chicago Broom Manufacturing Company, Chicago, Ill., has been incorporated with $30,000 capital to manufacture brooms and brushes. Incorporators, W. S. Carson, J. H. Roseboom, M. Cahill.

Lysle Engineering Company, Chicago, Ill. has been incorporated to manufacture, repair and deal in machinery. Capital, $25,000. Incorporators, R. W. Lysle, Geo. D. Whitefort, G. S. Burtis.

The Lockport Stamping Company, Lockport, N. Y., has been incorporated to manufacture hardware, builders' supplies, etc. Capital, $50,000. Incorporators, S. J. Clark, W. A. Babbitt, and others.

Centaur Motor Company of Illinois, New York Life building, Chicago, Ill., has been incorporated to manufacture motors and accessories. Capital, $10,000. Incorporators, A. M. Robbins, R. E Haley, A. E. Lake.

Bergesen Manufacturing Company, New York, has been incorporated with $25,000. Will establish machine shop and foundry. Incorporators, J. Bergeson, F. Lawrence, Brooklyn, and C. C. Dunbaugh, New York.

The Powers Railway Safety Appliance Company, New York, has been incorporated to manufacture railway appliances and mill supplies. Capital, $30,000. Incorporators, V. S. Mansen, E. A Sprong, S. S. Ryckman.

The Purdue Manufacturing Company, Chicago, Ill., has been incorporated to manufacture and deal in railway supplies, vehicles, etc. Capital, $10,000. Incorporators, Felix T. Graham, E. J. Hamilton, Jr., and E. A. Nicholson.

Biles Drier Company, Buffalo, N. Y., incorporated to manufacture drying machinery, filter presses, etc. Capital, $100,000. Incorporators, William Strohm, S. A. Benedict, Buffalo, and John W. Biles, Louisville, Ky.

The Brazil Machine and Foundry Company, Brazil, Ind., has been incorporated to manufacture clay-working and farm fence machinery. Capital, $50,000. Directors, D. H. Davis, Lewis McNutt, Jas. McClelland, etc.

The United Manufacturers, New York, has been incorporated to manufacture engines, machinery and tools. Capital, $100,000. Incorporators, Ernest M. Munn, J. A. Straussman, Walter K. Griffin, No. 27 Pine street.

The W. O. Dayton Automobile Company Chicago, Ill., has been incorporated with $10,000 capital. Will manufacture and deal in automobiles, engines and appliances. Incorporators, W. O. Dayton, T. A. Ryan, O. T. Cole.

The National Wrench Company, New York, has been incorporated to manufacture wrenches, nippers and tools. Capital, $150,000. Incorporators, W. C. Lawson, 1 Broadway; J. T. Condon, 64 Wall street, New York, etc.

Walter H. Stearns Company, New York, has been incorporated to manufacture cars, carriages, vehicles, boats, motors, engines. Incorporators, Walter H. Stearns, 540 West 58th street; J. C Snyder and Arthur G. Reynolds, 256 Broadway.

Making Big Guns at Bethlehem Steel Co.

Ingots, Tubes, Jackets, Hoops and Breech Blocks That Form Gun Barrel. Turning, Rough and Finish Boring and Rifling the Guns

BY E. F. LAKE

The large guns that are being made for the United States Government, by the Bethlehem Steel Company, at Bethlehem, Penn., have many interesting features attached to their construction on account of their size, and the accuracy with which the work has to be done.

Some mammoth machines are also required to do the work on, as the 12-inch gun barrel is over 46 feet in length, and this necessitates the use of boring and rifling bars of still greater length. When the head- and tailstocks and rests are added to this it means that the machine to do the work on must be around 125 feet in length. One lathe that was built to turn, bore, and rifle guns as large as 16 inches was 132 feet 9¼ inches in length, over all.

The 12-inch gun is the largest size that can be successfully operated with man power, although some of the 13-inch guns have been fitted up in this way, and for that reason but few of the larger sizes, such as 14- and 16-inch have been built.

The complete 12-inch gun equipment, when mounted on the disappearing carriage, is shown in Figs. 1 and 2. In Fig. 1 it is shown with the carriage lowered into a position that can be easily reached by the men for loading; while in Fig. 2 it is shown raised to the firing position. This enables the gun to be brought down behind breastworks where the men are fully protected and it can be loaded with safety. After loading it can be raised to a position that just clears the top of the breastworks, and then fired.

The guns are made of nickel steel and can be fired at the rate of two shots per minute. The shot has an initial velocity of 2550 feet per second. It exerts a muzzle energy of 47,300 foot-tons and with a normal impact at 8700 yards, or nearly 5 miles, it will penetrate the modern 12-inch armor plate.

The large volume of gas, and the high temperature produced from firing these guns with the smokeless powder used, causes an erosion inside the gun tube that makes it useless after about 60 shots have been fired.

There seems to be nothing in metallurgy that will produce a steel, or in chemistry that will produce a powder, that will overcome this erosion. The cost of the gun being in the neighborhood of $60,000 and each shot with its charge of powder costing about $500 it makes each shot fired from this gun cost $1500.

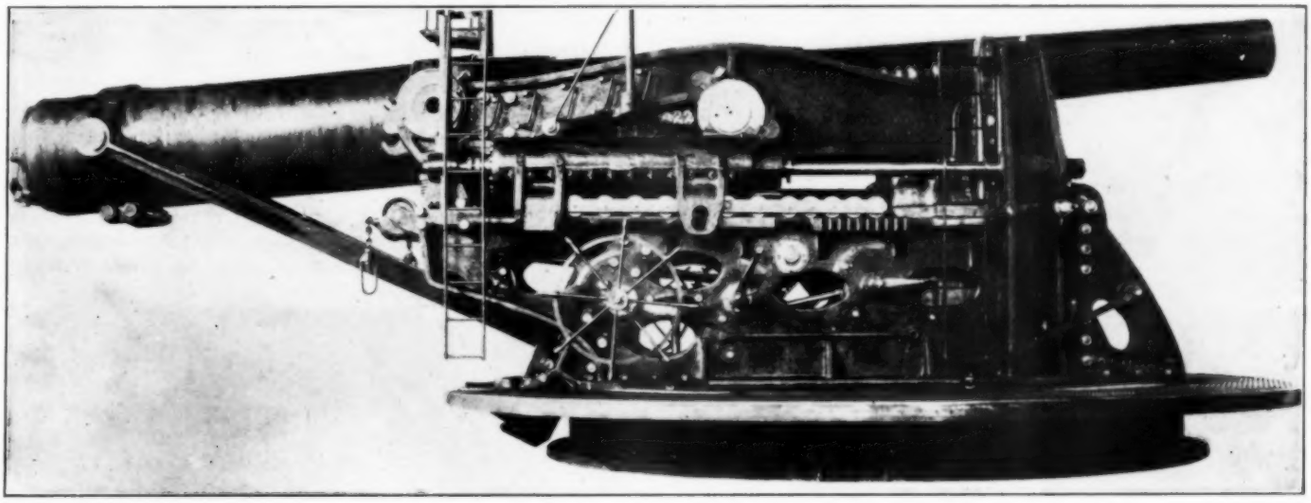


FIG. 1. DISAPPEARING CARRIAGE, CARRYING 12-INCH GUN, LOWERED BEHIND BREAST WORKS FOR LOADING

The interior of the No. 2 machine shop at the Bethlehem Steel Company's plant, which is the gun shop where these guns are made, is shown by Fig. 3. Partly finished guns will be seen down the center of the shop and a few of the many machines required in their manufacture can be seen on either side of them. Two other gangways are on each side of this central one, back of the pillars that support the traveling-crane tracks and roof, and these are lined with machinery for their entire length.

Tubes, Jackets and Hoops

The ingot from which the 12-inch gun tubes are forged and machined, is shown in Fig. 4, and the gun tube, after it has been rough-bored and turned, is shown in Fig. 5.

The ingot is cast in a fluid compressor, as by subjecting the metal to an enormous pressure, while it is molten, changing into a solid state, and cooling, the shrinkage that is inherent in the metal at this period is overcome and the pipe, or long hole down the center of the ingot at the top, does not form. This is shown by the solid metal in the top of the ingot, which is to the left of the half-tone, next to the steelmaker. This ingot as it stands weighs 114,363 pounds.

The ingot, which is 45 inches in diameter, is first taken to the 14,000-ton hydraulic forging press and forged into a bar of the proper diameter and length to make the tube. From there it is taken to the lathe where it is turned and rough-bored, as shown in Fig. 5.

This rough-boring is a very interesting operation, as the tube is 46 feet 1 inch long when finished, and it is bored from both ends to the center by two boring bars acting at the same time. When the hole is finished there is no offset in the center, as each boring bar has cut its way through its 23 feet of metal so perfectly that the hole looks as though it had all been bored from one end.

The tube is covered for about three-fifths of its length, from the firing end, by a jacket like the one shown in Fig. 6. This jacket is rough-turned on the outside and finished on the inside to a shrinking fit. The jacket is then shrunk on the tube by lowering the tube into a pit, heating the jacket, lowering it down over the

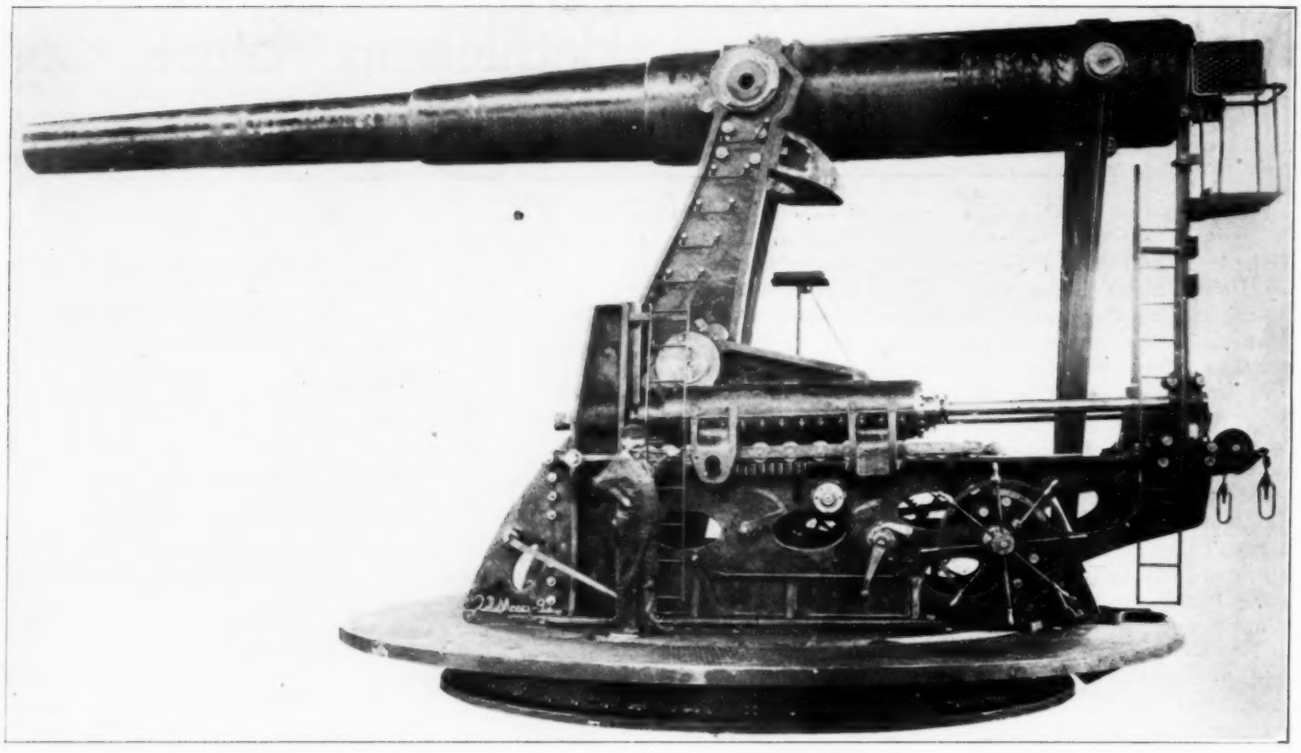


FIG. 2. DISAPPEARING CARRIAGE, WITH 12-INCH GUN, RAISED ABOVE BREAST WORKS FOR FIRING

tube, and holding it in position until it cools and tightly grips the tube. When the jacket is properly shrunk on it is impossible to get it off, as it and the tube are almost like one piece of metal.

The hoops shown in Fig. 7 are also shrunk on in the same manner as the jacket. One of these is shrunk on the muzzle end of the tube, and is called the chase hoop. The chase hoop is put on to strengthen this end of the gun, on account of the high terminal pressure of the smokeless powder that is used. Another hoop of a larger size, called the jacket hoop, is shrunk on the jacket, over the powder chamber, to further strengthen the gun at this point.

Turning and Boring

After the tube, jacket and hoops have been assembled, the gun barrel is taken

FIG. 3. THE GUN DEPARTMENT OF BETHLEHEM STEEL COMPANY, SHOWING MACHINERY USED IN MAKING BIG GUNS

FIG. 4. FLUID COMPRESSED INGOT 45 INCHES DIAMETER FOR MAKING 12-INCH GUN TUBES

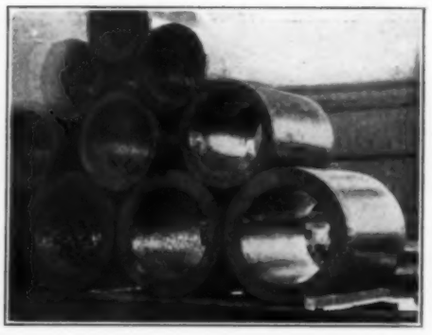


FIG. 7. PYRAMID OF HOOPS FOR BIG GUNS

to the lathe and finished on the outside by turning, as shown in Fig. 8.

The foundation for this lathe is lowered so that the three ways with which it is provided are level with the floor of the shop.

On the back and center ways are located the head- and tailstocks, the center support, and the apparatus used for guiding and driving the boring bars. On the front and center ways are located two tool carriages. Each of these tool carriages is operated by a mechanic, and the gun is turned up in about half the time that would be required if only one tool carriage with one man was used.

The gun is centered on and clamped to a face plate when turning it. The muzzle end of the gun is centered by a piece that fits into the bore, and is fastened to the spindle in the tailstock.

The spindle being too long for the operator to see his work if the hand wheel was located at the rear of the spindle, a gear is placed here and this is connected by a pinion, shaft, and two bevel gears, to a hand wheel located at the front of the tailstock.

The next operation is rough-boring the gun and to do this it is turned end for end in the lathe and fastened to the face plate at the muzzle end, so as to rough-bore it from the firing end, as shown in Fig. 9.

The boring bar being considerably over 46 feet in length, it is supported by passing it through a bearing mounted on the ways of the lathe, as seen in the extreme right of the half-tone. This bearing is moved up close to the gun when boring it and the boring bar is moved forward by the tailstock, in which it is fastened, traveling up to the work, the gun being revolved while boring.

The finish-boring operation is done in the same manner, by fastening a different cutter, like the one shown in Fig. 10, to the boring bar. In the finish-boring operation, however, the gun is again turned end for end and it is bored from the muzzle.

In all of these machining operations a special high-speed steel, that is made by the company, is used for the cutters, as the metal in the guns is very hard to cut when turning and boring them and the ordinary tool steels, or even some of the high-speed steels cannot be made to do the work.

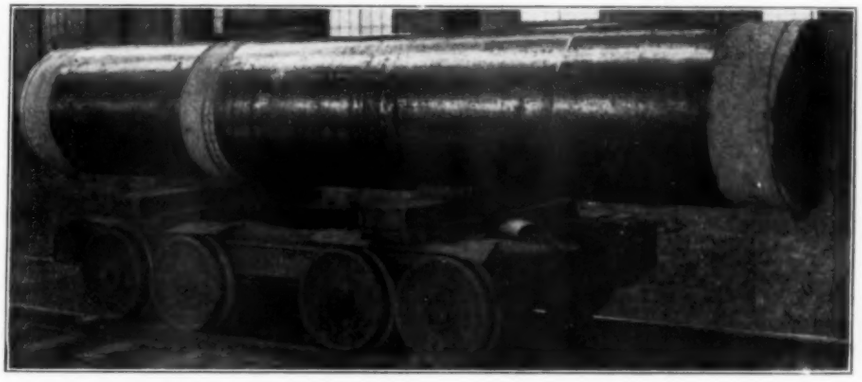


FIG. 6. JACKET FOR 12-INCH GUN ROUGH TURNED AND BORED

Rifling

A special machine, as shown in Fig. 11, is used for the rifling operation. In this the gun is held stationary and the rifling bar is given a slight twisting motion.

The cutter is pushed through the gun barrel and planes the rifling grooves on a circle that makes one turn of the barrel for every 25 calibers. Thus, this gun being 12 inches in diameter in the bore the rifling grooves would make one turn around the bore in a length of 25 feet, as 12 inches times 25 inches would be 300 inches, or 25 feet. This makes the rifling bar turn nearly two revolutions while planing the grooves, as the gun is 46 feet 1 inch in length.

To make the rifling bar turn while planing the grooves, grooves are cut in the rifling bar, as shown, and projections that fit these grooves are located in the guide bearing, shown close to the cutter. The rifling bar is thus made to revolve the required number of turns at the same time that it is moved forward to plane the grooves.

The Breech Block

The fitting of the breech block is the

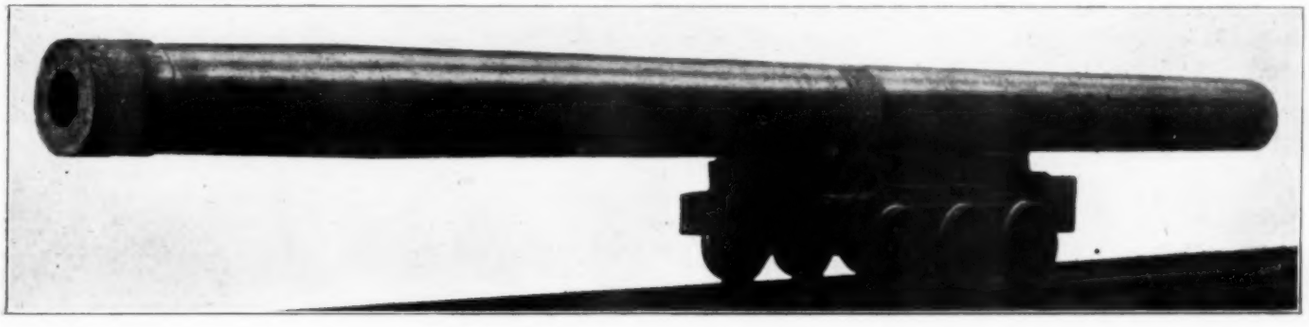


FIG. 5. TUBE FOR 12-INCH GUN ROUGH BORED AND TURNED

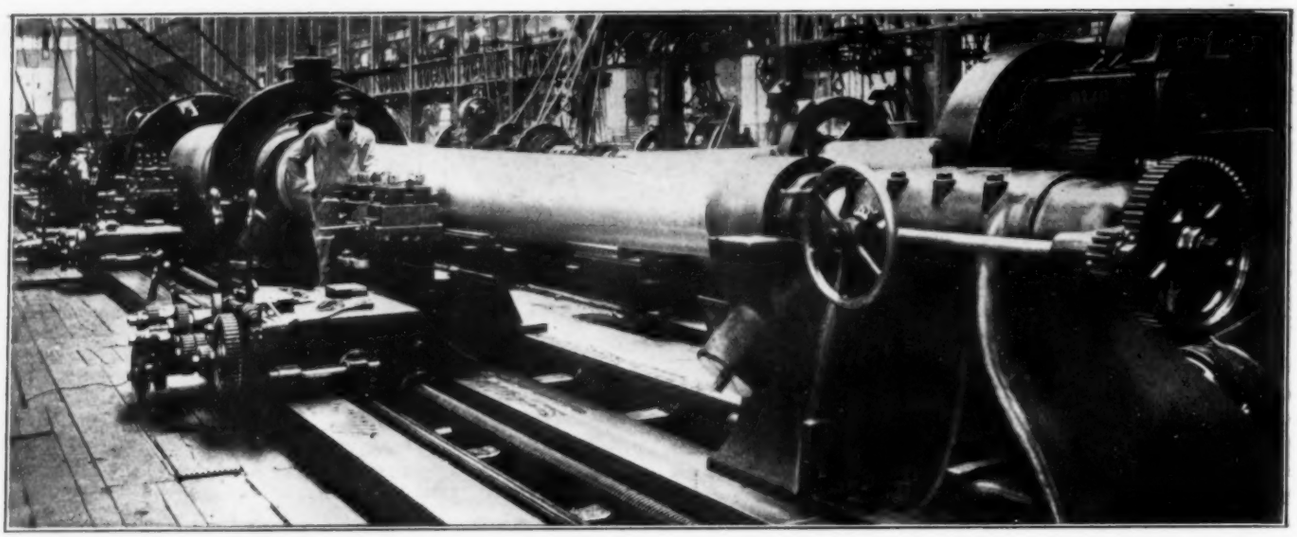


FIG. 8. TURNING THE 12-INCH GUN BARREL IN A SPECIAL LATHE

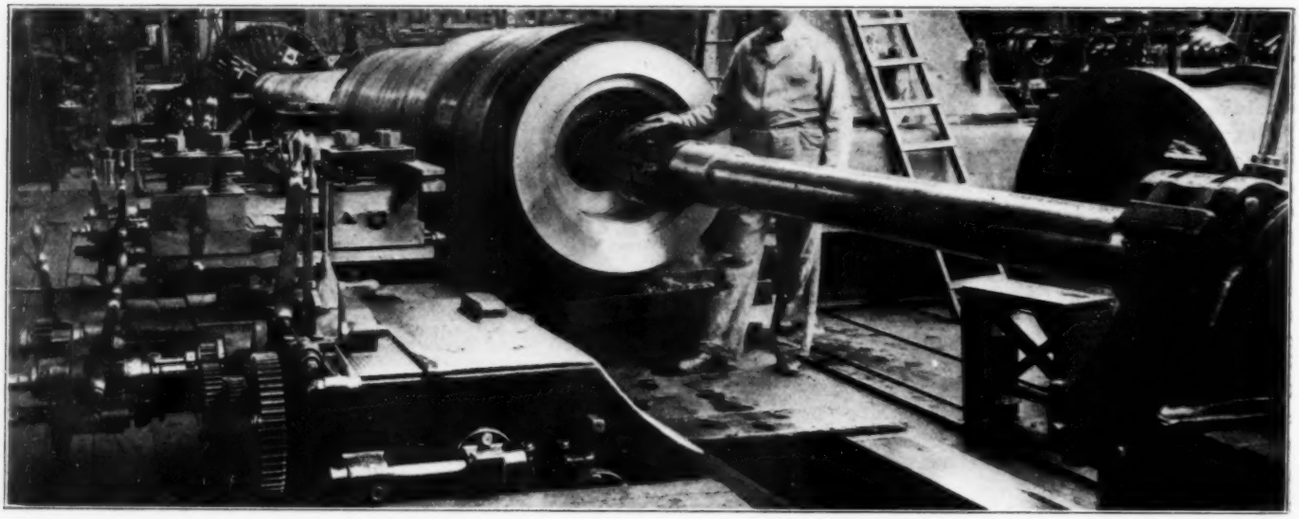


FIG. 9. STARTING TO ROUGH BORE A 12-INCH GUN BARREL

FIG. 10. STARTING TO FINISH BORE A 12-INCH GUN

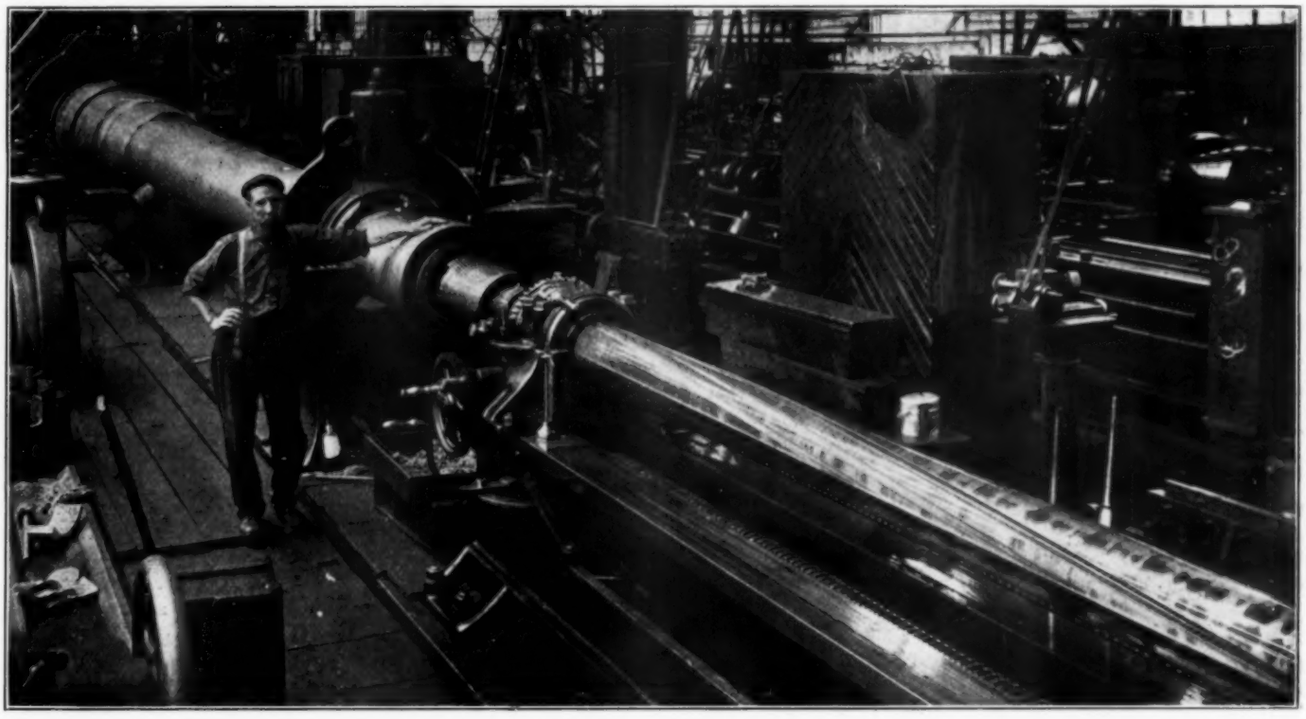


FIG. 11. READY TO START RIFLING THE 12-INCH GUN

final operation before mounting the gun on its carriage. This breech block, with the mechanism for operating it, is shown mounted on the gun and open ready for loading in Fig. 12, while it is shown closed ready for firing in Fig. 13.

To clamp the breech block tightly in position, and hold it there so it will withstand the shock and pressure exerted by the explosion, an interrupted thread has been adopted as the simplest and most powerful means.

The breech block is operated by a crank, which, when turned first unscrews it, then slides it out, and then swings it out of the way. The turning of the crank is all that is necessary to perform all three of these movements, in either opening or closing the breech block, and this can be done several times a minute.

The turning of the interrupted thread is one of the most interesting operations in the machining of these guns. This is done on a special machine that was built by the company for its own use.

The thread is a continuous one around the entire circle, but it is cut on three

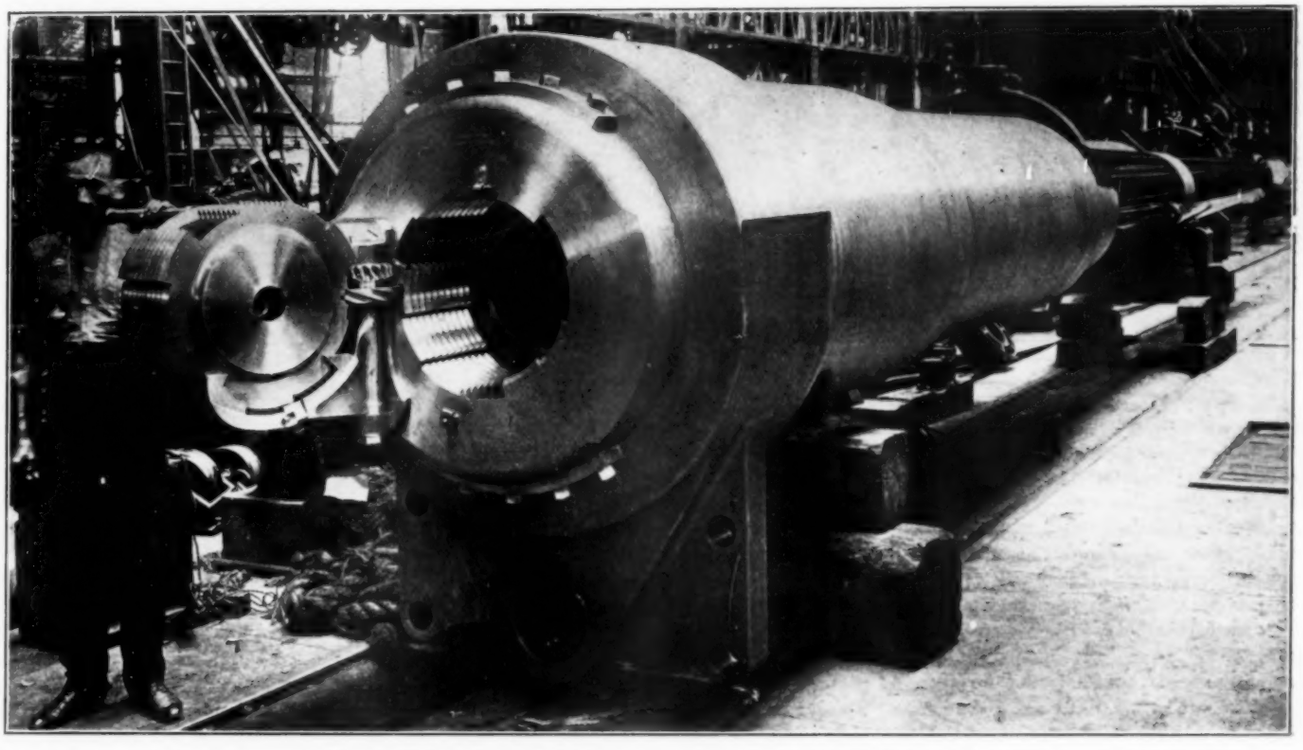


FIG. 12. THE BREECH BLOCK FITTED TO GUN AND OPEN READY TO LOAD

different elevations or planes, and this is done without stopping the machine. The tool starts its cut on the thread at the lowest elevation, which would be the smallest diameter on the breech block and the largest diameter in the gun, and after cutting this it is suddenly jerked back, while it is traveling ⅛ of an inch, to cut the thread on the next elevation. This is repeated for the third elevation, after which it is returned to cut the lowest elevation on the next series.

According to United States Consular report, real and rapid progress has been made in France in overcoming the past objections to the use of alcohol as a power producer, and an important French manufacturer of carbureters is reported to have expressed the following: "We esteem the question of the industrial use of the alcohol motor as definitely resolved, and the carbureters created in view of this utilization have given satisfactory results. The use of alcohol will become more advantageous when an understanding is brought about between the producers, prices obtain some fixity, and when the State shall have solved the question of denaturing agent.

Accepting Lessened Effectiveness Gracefully

By Entropy

Today a man took me to task for championing trade-school education for boys, on the score that the graduates would drive such men as he out of work. This man is some 60 years old and a good machinist of the kind of his youth. One of the kind that resents the new steels and rebels at premium plans for paying for work. In fact something of an old fogy. He thinks that technical graduates are doing work that he ought to do, and fears that it will be worse when trade-school graduates begin to enter the field. This, of course, might be disposed of on the theory of the survival of the fittest; by saying that, unless he has been fitting himself by experience supplemented by study he ought to be supplanted by a younger man; or by the Rooseveltian theory that he should have provided himself with children who would see that their father was enjoying a long deferred rest.

It may also be said generally that when a man has passed his 50th year without advancing beyond the machinist stage the chances are that even if he had been given the advantage of education it would have done him no good. At 50 most men begin to decrease in vigor. They know it; they are as strong, but they lack that push to drive things that carried them up to their top notch of wages in their younger days. By the time a man has reached that age he should have placed himself in a position where his counsel should be worth more than his work. If a few have not placed themselves in this position it should not be an argument against educating young men to fill positions which are being made vacant every day by death and promotion. The young men push some of the older ones up into better positions and some they push out. These latter are out, however, only because they are too proud to start back down the hill that they have climbed.

There are a few men who meet the turning point of life with the good grace of another friend of mine whom I met after having missed him for several years. "Well, Entropy," he said, "I brought up my son and gave him a pretty good start, got my two daughters well married, and then discovered that it was hard work to

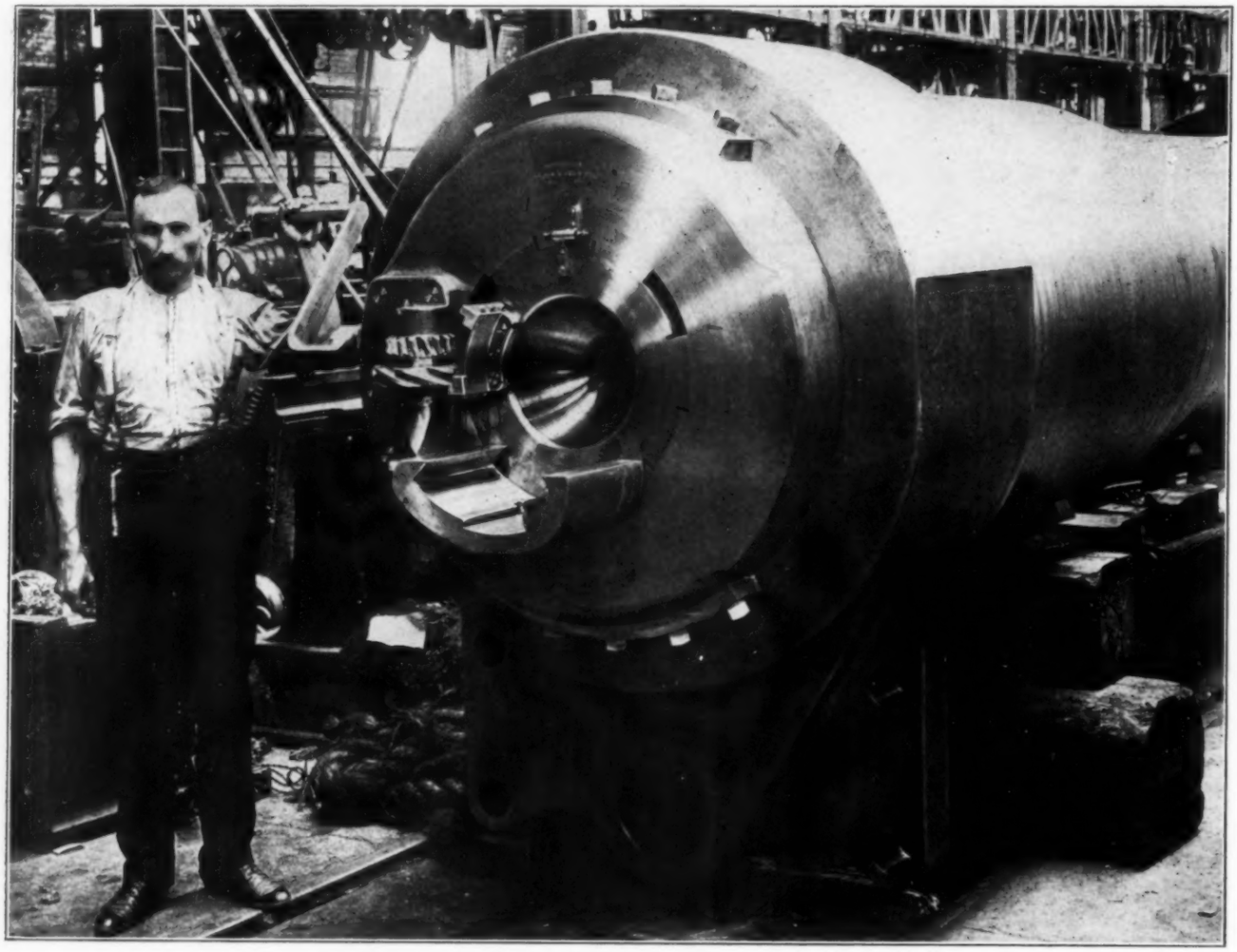


FIG. 13. THE BREECH BLOCK CLOSED READY FOR FIRING

spend my wages. You see wife and I had pinched so hard and so long that the habit had us. We no longer cared for those expensive pleasures that we had once given up for the children's benefit. We talked the matter all over and decided that we could live on what I could earn as a lathe hand and still save money. We felt that in educating our children better than we were educated we had done as much for them as if we had left them several thousand dollars apiece, and we decided that we could lay back the rest of our lives with clear consciences. So I left the old job where I was foreman when we met before and went over to Joe's and took a job in the tool room. I am still there and am glad I made the change. I take a day off occasionally when I know I can do it without anybody's suffering. I have no responsibility beyond my own work. If they ever say I am getting slow and want to be rid of me I shall tell them that I want a little poorer paid job, but they can't shake me off until I get down to sweeping the floor. My boy would gladly support us both, but he won't have the chance for awhile yet. I can go down the ladder just as well as I went up, and I am not ashamed to do it."

Brazing Small Typewriter Parts

EDITORIAL CORRESPONDENCE

As extensive and successful a use of brazing in the production of small parts as we have ever seen is at the factory of the Pittsburg Writing Machine Company, Kittanning, Penn. It is no exaggeration to say that brazing is one of the most important manufacturing operations in connection with the manufacture of the parts for their new machine, known as the Standard No. 11 typewriter. Through the courtesy of their superintendent, J. W. Paul, we are enabled to show a few of the parts of this machine typical of the use that is made of the brazing process.

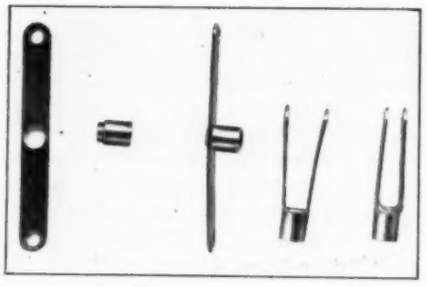


FIG. 1. A SMALL TYPEWRITER PART ASSEMBLED BY BRAZING

Fig. 1 shows a small connection that is made in large numbers; at the right is a finished piece which is 5/8 of an inch long. Beginning at the left of this illustration are shown the punching that forms the two legs of a connection, then the hub, which is followed by the hub and punching assembled. In this form the hub is slightly riveted over in order to hold the two pieces together. The next view shows the connection with the legs bent and ready for brazing. In this form it is brazed to form a perfectly smooth, clean joint, and is then finished as indicated by the view at the extreme right. Although some of the detail is lost through reproducing by means of halftone, still the smoothness of the brazed joint can be seen.

Fig. 2 shows a few other parts from this typewriter, all of which have been assembled by brazed joints. Taking the upper row of pieces and beginning at the left, a reinforcing piece is shown brazed to the lever, a simple and effective means for producing a part of this character. In the center of the upper row is a key bar shown both disassembled and assembled.

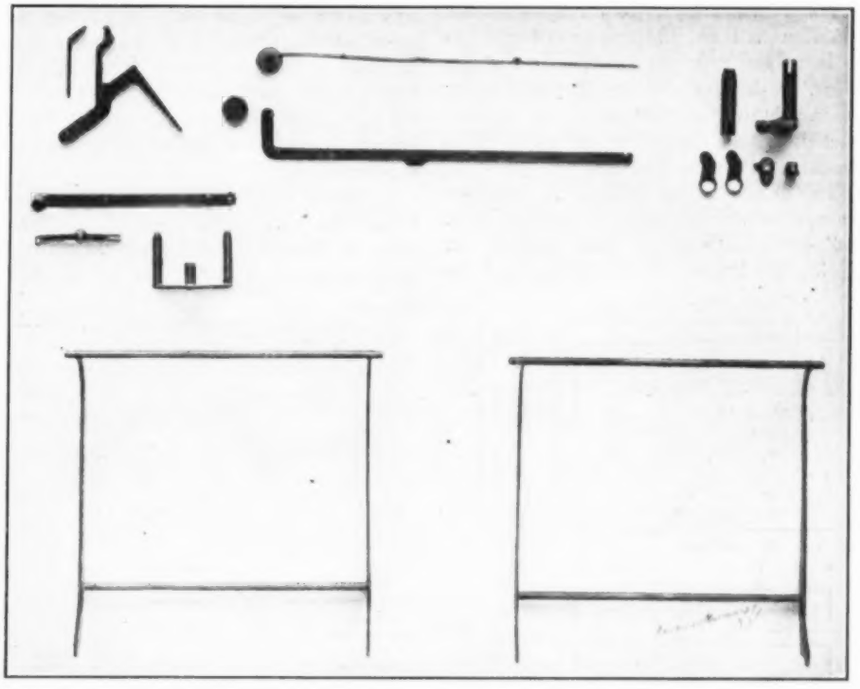


FIG. 2. A GROUP OF TYPEWRITER PARTS ASSEMBLED BY BRAZING

The operation of assembling consists in slightly riveting over the end of the bar after it has been slipped through the base of the key and then brazing the joint. The right-hand piece in this upper row is shown built up of several component parts; brazing is the process used for assembling. Returning to the left-hand edge of the illustration, several smaller parts are shown at about the middle of the hight, where various studs and hubs are assembled into connecting pieces, all by this same simple process of brazing. In the lower part of the illustration is a frame, the construction of which is of interest. It is shown at the right assembled for brazing the upper bar into place, and at the left with this same bar properly joined. Near each end of the bar is turned a shallow groove, into which fits the forked end of the side pieces of the frame. After these forked ends have been slipped around the bar the protruding ends are bent over to fit into the groove and practically fill it. The resulting joint is then carefully brazed, making a frame which is essentially without joints and is therefore more rigid, stronger, and more pleasing in appearance than any similar structure could be made provided the joints between the component parts were mechanical joints only.

THE BRAZING FURNACE

In order to produce this work, Mr. Paul has developed a special brazing furnace, yet one that is most simple. From the geographical location of Kittanning it goes without saying that the fuel is natural gas. This gas is burned in an old-fashioned natural-gas mixer, which is little more than a hollow cast-iron sphere with suitable connections for admitting air and gas, and an outlet leading to the flame. This mixer is mounted on a small cast-iron base and is surrounded by a cylinder which has a sheet-steel shell and a thick lining of fire clay. On top of this is placed a small disk of fire clay with an opening at the center, and over all a hood. The pieces to be brazed are heated at the opening through the upper disk under the hood. The heating results are all that could be desired, for in the case of smaller pieces, such as illustrated by the connection of Fig. 1, the heating seems to be almost instantaneous when the piece is brought into the region of flame. This type of furnace is made in various sizes in order to adapt it for various classes of work. As carried out the process of braz-

ing is extremely rapid. Referring again to Fig. 1, a boy operator will make 1800 brazed joints per day on the small connection there shown.

The advantages of this type of joint for small parts such as we are illustrating and for many other small parts used in the typewriter are many; the result is one of the most perfect joints which it is possible to make, and a far better one than a joint made by mechanical means only, thereby insuring a maximum of strength and rigidity, and at the same time permitting the use of lighter sections of metal.

Molding Anchor Holes in Automobile Bearings

By R. E. Martin

In designing gasolene engines much attention, thought and study is given to the crank-shaft bearings. It is not so much a question to build the engine correctly as it is to make proper provisions for any wear, or shifting of parts, that may occur in the future, so that they can be corrected by an expert or otherwise in a simple and mechanical way.

The design of cap or upper ½ box now in use on the crank-shaft bearings of a high-grade automobile, the method for keying the babbitt in the journal and the pattern and core box for the cap, are shown in the illustrations. These show how the latter is made, so that the anchor holes are all made in the casting instead of drilling them in the cap as is the general practice.

What I wish particularly to call attention to is the construction of the core box and to make this more clear I have shown the construction of the pattern also. The pattern is made in two pieces of four caps each, as at *A A A A*, and their print *P P*, as shown in Figs. 1, 2 and 3. They are connected together by a gate, shown in Fig. 1, and mounted on a pine match board 1 inch thick; the flask, both cope and drag, is cast iron. Between 350 and 400 caps are made in a day's work. Some caps have 8, and others 10 anchor holes, which means some drilling when it is done on a drill press. On the other hand, it means some saving when this can be done, in a practical manner, in the foundry with but little, if any, extra cost.

In Fig. 5 is shown a section of the core box. The babbitted journal is 2¼ inches in diameter, with the babbitt ⅛ inch thick, and the anchor holes, 10 in each cap, 7/16 inch in diameter and ⅛ inch deep. The wood forming the box is worked out 2¾ inches in diameter, as shown, and the full length of the prints over all plus 1½ inches. After this the end pieces are nailed on as in Fig. 4.

A piece of pipe, brass or iron, is cut the same length as the half circle in the box. In this pipe, in the locations indicated in Figs. 1, 2 and 5, are drilled and taper reamed, holes *B, C, D* and *E*, 7/16 inch in diameter. Holes *B* and *C* are drilled parallel to line *N M*. and *D* and *E* to line *N O*, Fig. 5. Next the pipe is put into the milling machine and cut lengthwise so as to make a parting, or point, at the center, and two more cuts to make the sections come flush with the face of the core box. In other words the pipe is cut in halves and again the half is cut through the center to make two quarters.

As noted above, the box is 1½ inches longer than the prints over all; the purpose of this is as follows: When the pipe sections, or shells, are in the box, a half-round block ¾ inch thick is placed at either end, as shown in Fig. 4. This makes the core box the correct length and also acts as a support to the shells when the box is rolled over and drawn away, thus preventing the sand from being crushed by the weight, or the act of lifting, either section. The wooden box is lifted square up, after which each section is drawn away; *B C* on a line with *N M* and *D E* with *N O*. If the box is made correctly, 40 anchor holes can be made in the time required to drill one hole.

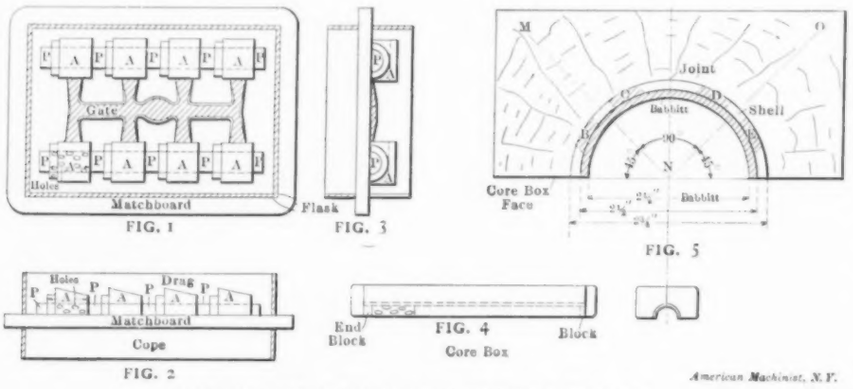


FIG. 1 FIG. 3 FIG. 5 FIG. 2 FIG. 4

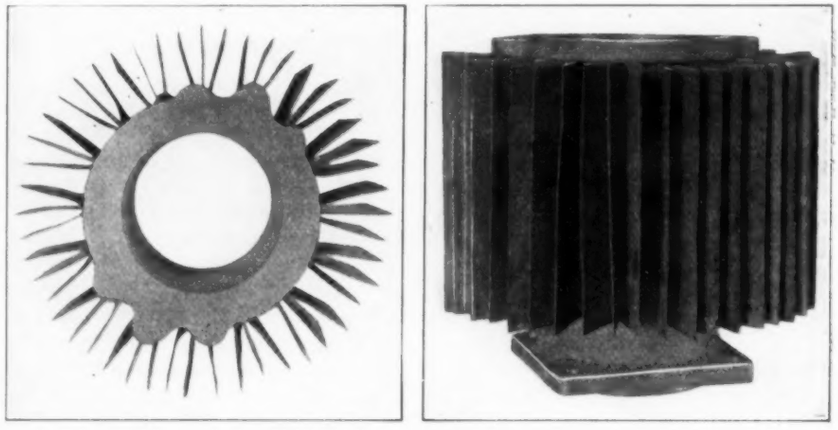
MOLDING ANCHOR HOLES IN AUTOMOBILE BEARINGS

Novel Air Cooled Cylinder

The air-cooling surfaces in this cylinder are sheets of copper cast in place when the cylinder is forged, and in this way securing perfect contact by being actually fused in position. While this has been attempted before, it has always been met with the difficulty of melting off the edges of the copper strips, which came in contact with the molten iron, owing to the much lower melting point of the copper.

This is obviated in this case by having the copper strips cast into ridges, or projections, on the outside of the cylinder body, and the success of the method depends on the proper proportioning of these ridges to the copper that is to be cast in place. In the cylinder shown this has been so well proportioned that although a large amount of iron was run through the mold in order to see if it was possible to melt the copper strips, the only result was their being secured fused in place to such an extent that it is impossible to remove them by even the most severe abuse. The projections into which they are cast are so small in comparison with the cylinder body that it chills sufficiently to prevent the overheating and melting of the copper which comes in contact with the molten iron.

This is the invention of Henry Fenn, of the Taylor-Fenn Company, Hartford, Conn., to whom we are indebted for the photographs.



NOVEL AIR-COOLED GAS-ENGINE CYLINDER

Tests of Lathe Tools for Finishing Cuts

Interesting Diagrams Obtained by Means of a Special Indicator Applied to a Series of Test Bars Finished with Various Forms of Tools

BY W. A. KNIGHT

It is well known, or at least is the pretty general impression among good mechanics, that to turn a piece round and true requires the use of a fine-pointed tool, fine feed and light cut, and that the more we deviate from these conditions in the way of increasing feed, depth of cut, or radius of tool point, the more the work will deviate from true circular section.

It is conceded that work is finished by grinding when a number of duplicate parts are carried through at a time, both quicker and better than when finished in a lathe, but there are numerous cases, and probably always will be, where it is expedient to finish the work in the lathe. The question then arises, what kind of a tool shall be used to give the best results?

In the selection of a tool for finishing cuts, a number of things must be taken into account; such as the kind of surface left by the tool, on which depends the amount of filing and finish necessary, the tendency to chatter, the amount of surface the tool will cover before regrinding, the roundness or quality of the work, and the time required to get the work out. If we use a fine-pointed tool with fine feed to gain in quality, we do so at a sacrifice of time, for with a broad-nosed tool, the cutting speed can be higher, also the feed can be increased and still the amount of filing and finishing necessary to take out the tool marks kept below that required with the finer pointed tool. The problem then, largely resolves itself into a question of quality on the one hand and quantity on the other.

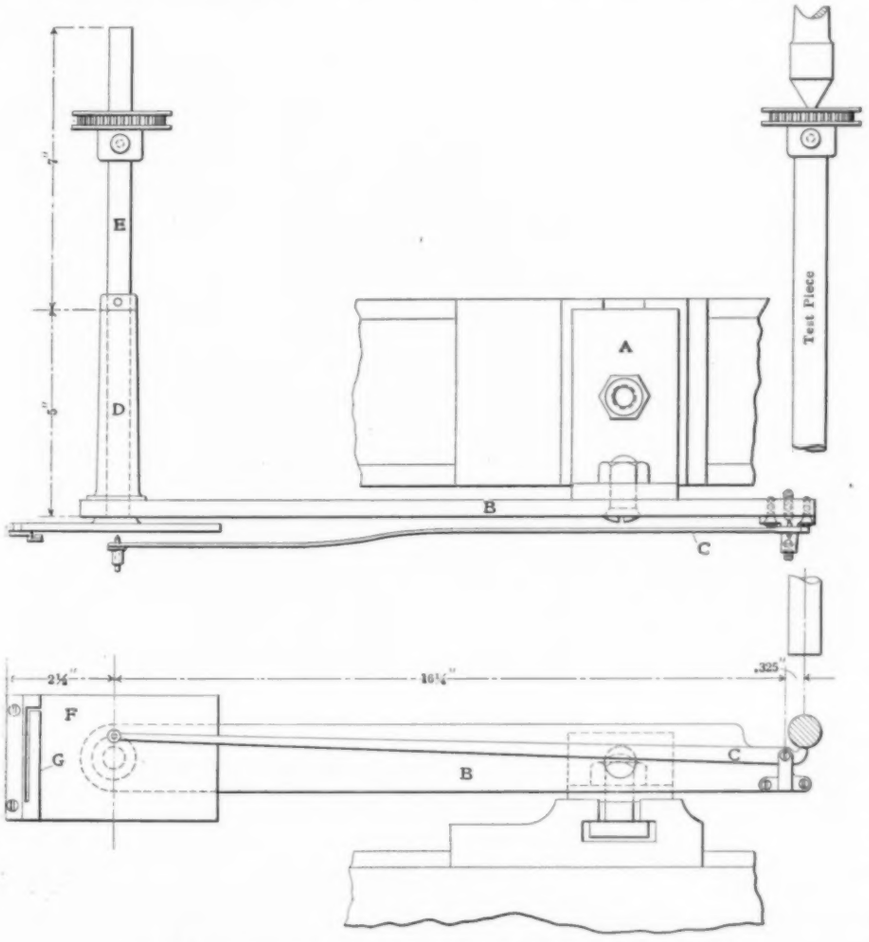


FIG. 1. INSTRUMENT FOR TESTING LATHE WORK FOR ROUNDNESS

The Test Instrument

For the purpose of investigating the effect of different kinds of tools on the roundness of the work, and possibly to add a little more definiteness to our knowledge of the cutting action of small lathe tools, the instrument shown by Fig. 1 was constructed. It was also thought that the diagrams drawn by the use of the instrument could be used to good advantage in demonstrating to the student, or others, just how much a supposedly round shaft may vary from true roundness.

An understanding of the instrument can be had by reference to Fig. 1. *A* is a bracket to which is fixed an arm *B*. At one end of the arm there is pivoted a light lever *C*, and at the other end there is attached a bearing sleeve *D* through which passes a shaft *E*. This shaft is ground and lapped to a good fit in its bearing, and carries on one end the plate *F*. The diagrams are taken on a piece of smoked glass, the glass being held to the plate *F* by the spring clip *G*. In operation the instrument is bolted to the tool block of a lathe by the bracket *A*. The piece to be tested is held between centers, one end having been turned down to receive a small shrouded pinion. A like pinion is placed on the shaft *E* and a section of rack laid across from one pinion to the other. Any rotation of the test piece will then cause a corresponding rotation of the shaft *E* together with the plate *F* and smoked glass. The cross slide of the lathe is adjusted so that the short arm of lever *C* comes in contact with the test piece. The long arm of the lever carries a steel tracing point. It is then just like a sensitive test indicator and when the test piece is rotated, its out of roundness or untruth will be indicated by a movement of the tracing point, the movement magnifying the error about 50 times. Obviously then, if the smoked glass is rotated at the same rate as the test piece, the tracing point will describe a contour of the test piece with its irregularities also magnified about 50 times. After the contour line has been drawn, the rack is removed, the position of the tracing point changed slightly, and the shaft carrying the smoked glass given another rotation, thus describing what might be termed the proof circle. This is simply a circle of a little larger diameter than

FIG. 2 FIG. 3

IRREGULARITIES IN FINISHED LATHE WORK. ERRORS MAGNIFIED ABOUT 50 TIMES

the contour circle and is drawn for the purpose of comparison only. If the test piece is perfectly round and runs true on centers, the diagram should be two true and concentric circles. If the piece is round, but runs off center, the lines should be true circles, but eccentric with each other. The diagrams then represent not only the irregularities in the surface of the piece being tested, but also the amount it runs off center. Fig. 2 shows a characteristic diagram.

Testing the Instrument

Smoked glass was selected for the diagrams because it was essential to keep the friction of the tracing point down to a minimum, a very light contact being sufficient to trace a clear line on the glass. As a test of the friction and accuracy of the instrument, the diagram shown by Fig. 3 was taken. By elevating or lowering the cross slide of the lathe a little, the tracing point could be made to describe a larger or smaller circle on the glass. Starting then with the inner line, Fig. 3, the successive lines were drawn by simply changing the elevation of the cross slide, using, of course, the same test bar all the time. It will be seen that the irregularities in the lines are reproduced with scrupulous exactness and hence are caused by irregularities in the surface of the test bar and nothing else. It may be added, however, that other tests were applied, such as running around the line several times, and running backward and forward over the same line, with equally satisfactory results.

Fig. 4 shows the instrument on a lathe with test bar in place.

Device for Setting the Tools

At the beginning of the experiments the lathe centers were ground to a sharp point and the tools were adjusted for hight by this point. This proved unsatisfactory, and the attachment shown in Fig. 5 was made for the tail spindle. This is simply a piece bored out to fit the spindle, split through and provided with a clamping screw so that it can be tightened up on the spindle. To the upper end is attached a 1-inch micrometer. The anvil has been taken out of the micrometer and a bushing put in its place through which passes a light stem, as shown in the sketch. To get the exact center we put on lathe centers a piece of any convenient diameter, run the stem down until it makes contact and take the reading. Subtracting one-half of the diameter of the piece from the reading gives the exact center. The setting piece is then removed, the tool point brought under the stem and its hight adjusted to this reading. By this arrangement it is possible to adjust the tool point to the correct hight to within a fraction of a thousandth.

The Tools and Test Bars

In making the experiments on tools the idea was to take a light finishing cut over prepared test bars with different kinds of tools, keeping all conditions constant except the shape of the tool, and compare results for roundness. Eighteen tools were ground up, as shown in Fig. 6. All of the tools had the same clearance, 6 degrees, and the same back rake, 15 degrees, but the first six had no side rake, the second six had 10 degrees, and the third set of six had 20 degrees side rake. The radius of points varied from 0.015 to 0.15 inch.

The test pieces were made of about 28-point carbon steel, 16 inches long, 13/16 inch diameter in the rough. Two cuts were run over them in the lathe, and they were then finished by grinding to a uniform diameter of 0.760 inch. They were then put in the lathe again and a light cut run from the end to the center of each, with the different tools, the diameter being reduced to 0.750 inch. This made the depth of cut 0.005 inch. The feed was 105 per inch and the cutting speed 35 feet per minute. They were then carefully filed in a speed lathe making 920 revolutions per minute, just sufficient to take out the tool marks. Measurements were taken at the end and in the center both before and after filing and the amount required to take out the tool marks noted. Diagrams were then taken from the middle portion of each bar.

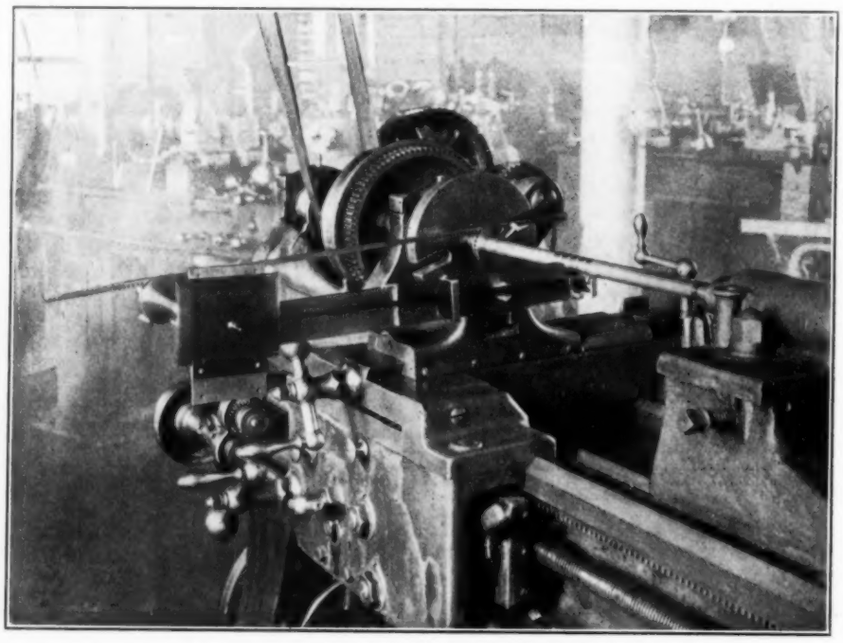


FIG. 4. THE INDICATING DEVICE ON THE LATHE

Results with Different Tool Points

It was thought the test bars (16 inches long, ¾ inch diameter) would be springy enough to show quite a difference in roundness between the ones turned with a fine-pointed tool (0.015 inch radius) and the ones turned with tools of large radius (0.15 inch), but contrary to expectations there was practically no difference in the roundness. Fig. 7 shows the diagrams taken from the bars which were turned with the first six tools, that is, diagram No. 1, Fig. 7, is from the bar turned with tool No. 1, Fig. 6; diagram No. 2 with tool No. 2, and so on to diagram No. 6 from bar turned with tool No. 6.

The set of diagrams (Fig. 7) merits a little closer inspection. Bear in mind that the out of roundness is here magnified about 100 times, and that with No. 1 the bar was turned with a tool having a point 0.015 inch, or less than 1/64 inch radius, and that No. 6 is from a bar turned under the same conditions except that the tool had a point of 0.15 inch, or nearly 3/16 inch radius. If the test pieces were made shorter in comparison to their diameter, it is logical to suppose that they would come out more nearly round, and conversely if longer, the out of roundness would be increased. Since it is not likely that a piece of any greater length in proportion to its diameter (21 to 1 in this case) would be turned without a rest of some kind, it follows that we have here the maximum difference in the roundness which is likely to occur in practice when using this extreme difference in tools, and this is, as will be seen from the diagrams, so small that it would be difficult to tell which was turned with the fine-pointed tool.

Although the test pieces were cut from the same bar, it was thought that the material might vary enough along the bar to invalidate these results. The form of test bar was, therefore, changed to that shown in Fig. 8. The bars were turned to ¾ inch diameter except at the six enlarged portions in the center. These were finished by grinding to 0.765 inch and the test cuts run over the raised portions. Of course, the bar would be subject to more spring when turning the spots near

the center, but spots 1 and 6, 2 and 5, 3 and 4, would be turned under exactly the same conditions as far as stiffness of bar went, and it was thought that the greater uniformity of material secured by the use of this form of bar would more than offset the difference due to the difference of spring. A number of tests were made on bars of this kind with results substantially the same as those shown by Fig. 7.

The results indicate that so long as we keep the feed and depth of cut the same, there is no advantage as far as roundness of the work goes in using a fine-pointed tool.

Effect of Increased Feed and Radius of Tool

When using a tool with point of large radius it is quite natural to use a coarse feed, hence tests were made to see what effect a change of both feed and radius of tool would have on the roundness. Feeds of 150, 105, 74, 61, 52 and 43 per inch

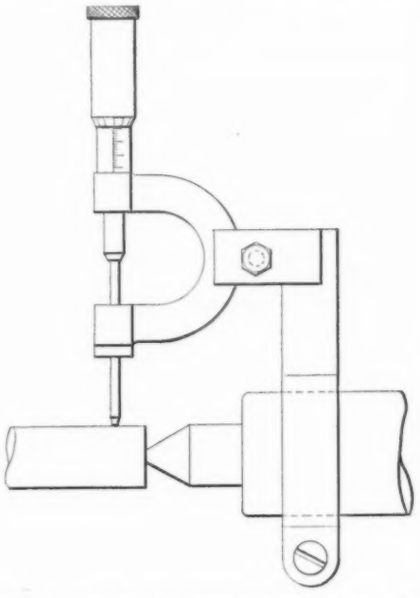


FIG. 5. DEVICE FOR SETTING TOOL ON CENTER

were used; these being calculated so as to leave theoretically the same amount of filing to take out the tool marks.

Fig. 9 is a typical set of diagrams from this series and they show that the out-of-roundness increases very materially under these conditions. In Fig. 9 diagram No. 1 is from a bar turned with a tool of 0.015 radius, feed 150 per inch; No. 2, radius 0.025, feed 105; No. 3, radius 0.050, feed 74; No. 4, radius 0.075, feed 61; No. 5, radius 0.10, feed 52, and No. 6, radius 0.15 and feed of 43.

In Fig. 10 we have a set of diagrams showing the effect of varying the feed alone, all other conditions being kept constant. The bars were turned with tool No. 6, *B*, that is, a tool with point of 0.15 inch radius and 20 degrees side rake. The feed was varied the same as before, or from 150 to 43 per inch. The diagrams show clearly that out-of-roundness increases with an increase of feed.

Essential Conditions for Round Work

It appears, then, that the essential conditions for the turning of a piece round and true are that we use a fine feed and light cut, or in other words, the area of cut must be kept as low as possible. Increasing either feed or depth of cut has far more influence on the roundness than increasing the radius of tool point. Thus a piece turned with a tool of 3/16 radius, feed 150 per inch, would be more nearly round than if turned with a tool of 1/16 radius and feed of 100, the depth of cut being the same for each.

These results are at variance with the generally accepted ideas of the fine-pointed tool. It is probable that the misconception arises from the fact that when using a fine-pointed tool, a fine feed and light cut are almost always used at the same time, and what has been ascribed to the tool in the way of producing round work, has in reality been due to the fine feed and light cut.

All Tools 6 Degrees Clearance, 15 Degrees Back Rake

No Side Rake	10 Degrees Side Rake	20 Degrees Side Rake	
No. 1	No. 1 A	No. 1 B	Radius of Point .015
No. 2	No. 2 A	No. 2 B	Radius of Point .025
No. 3	No. 3 A	No. 3 B	Radius of Point .050
No. 4	No. 4 A	No. 4 B	Radius of Point .075
No. 5	No. 5 A	No. 5 B	Radius of Point .100
No. 6	No. 6 A	No. 6 B	Radius of Point .150

FIG. 6. SHAPES OF TOOLS

Filing

As before mentioned the test bars were measured after taking the cut and then again after being carefully filed, just enough to take out the tool marks. The data thus secured show that the tools without side rake leave, in general, better surfaces than those with side rake; i.e., less filing is required to finish the surfaces. Theoretically a diamond-point tool ground up to a sharp point and then flattened off an amount a little greater than the feed, will leave a perfectly smooth surface, but I have discarded this tool in favor of the round-pointed tool because of its greater tendency to chatter (as shown by F. W. Taylor), the difficulty of setting it so that the flat is exactly parallel to the work, and because the leading corner dulls more quickly and hence the tool will not cover the surface that a round-pointed one will. For a round-pointed tool the theoretical amount required for taking out the tool marks is given by the equation:

$$\textit{Reduction of diameter} = 2r - \sqrt{4r^2 - f^2},$$

r being the radius of tool and f the feed. It was found though, that there is always more to take off than this equation indicates because the surface under the extreme point of the tool is not smooth. The equation takes care of the ridges left by the tool, but that is all. An average of 36 readings gave for tools of 0 degrees side rake, 1.16 thousandth; for tools of 10 degrees side rake, 1.32 thousandth; for tools of 20 degrees side rake, 1.50 thousandth, as the amount to be added to the theoretical amount to take out the tool marks. It will be seen that the amount increases with the side rake. As a possible explanation of this it may be said that with the tools having the most rake there appeared the most tendency to "streak in," that is, where the point of tool leaves a rough streak around or partly around the bar, giving the work somewhat the appearance of a water-finished surface in which water was momentarily cut off so that the tool ran dry for a revolution or two.

It should be kept in mind that these results were obtained with cuts of practically 0.005 inch in depth. This would, of course, be too much in some cases for finishing cuts and perhaps too little in others, but was thought to be a fair av-

erage value for light work. With a greater depth of cut I suspect the difference between tools with and without side rake would disappear, while for lighter cuts it would probably be greater than that given.

Fig. 11 shows graphically the relation between radius of tool, feed, and amount of filing. The curves are plotted for tools without side rake and corrected by the addition of the constant 1.16 thousandth. They are, therefore, supposed to represent the actual reduction of diameter necessary to obtain a finish. With a dull tool, or one improperly set, the amount may be considerably greater than that given, but under good conditions the curves represent fairly well the amounts to be taken off. In 108 readings, using different tools, different feeds, and with separate setting of the tool for each reading, the maximum difference between the amount as measured and that given by the curves was 0.00084 inch. It may be added that all of the tools used were machine-ground.

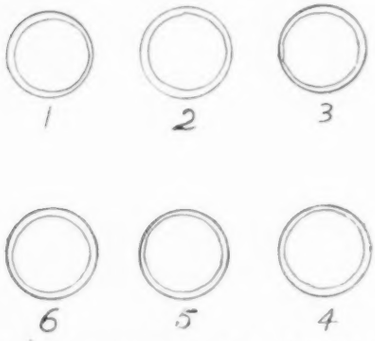


FIG. 7. RESULTS OBTAINED WITH TOOLS OF DIFFERENT RADIUS OF POINT

The same results are given in the accompanying table:

Feed Revolutions per Inch.	Radius of Tool Point.					
	0.015	0.025	0.050	0.075	0.10	0.150
200	1.58	1.42	1.30	1.26	1.22	1.20
150	1.90	1.60	1.38	1.32	1.28	1.24
120	2.34	1.86	1.50	1.38	1.34	1.28
100	2.98	2.16	1.66	1.50	1.42	1.34
80	3.88	2.74	1.94	1.68	1.56	1.44
70	4.78	3.24	2.18	1.84	1.66	1.50
60	6.22	4.02	2.56	2.08	1.86	1.64
50	8.80	5.34	3.24	2.50	2.16	1.84
40		7.86	4.32	3.34	2.74	2.20
30			6.88	4.92	3.96	3.02
20				9.74	7.52	5.36

TABLE GIVING REDUCTION OF DIAMETER IN THOUSANDTHS TO OBTAIN A FINISH. FOR TOOLS WITHOUT SIDE RAKE.

Chattering

When making the test for roundness on the regular test bars, the condition of surfaces with reference to chatter marks was noted. There appeared slightly less tendency to chatter with the tools having most side rake, but the chattering was not marked enough to warrant any definite conclusions. To try this point out farther, test bars ⅝ inch in diameter, 24 inches long were prepared. A cut was run from one end to the center with a tool having no side rake, the bar reversed and a cut taken over the other end with a tool having 20 degrees side rake. It was thus possible to compare the tools on the same bar under practically the same conditions. No rest was used. The tools with side rake showed less tendency to chatter than those without, but on the other hand the tools without side rake left (where chatter was absent) better surfaces than those with side rake.

It developed that the speed of rotation was an important factor in producing chatter. As an illustration test bar No. 35 is taken. The cut proceeded nicely until 1½ inches from the end. Violent chattering began at this point. The speed was reduced from 160 to 95 revolutions per minute. This stopped all chatter and the cut proceeded smoothly until 7 inches from the end when excessive chatter again began. The speed was reduced to 66 revolutions per minute, which again stopped the chatter until the cut had reached a point 11 inches from the end. At this point no further reduction of speed would stop it.

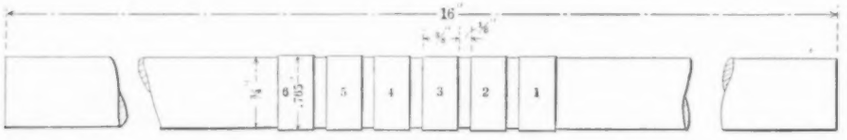


FIG. 8. TEST BAR

The same thing happened with other bars with the exception that the first chatter spot occurred at different distances from the ends, varying from 1½ to 3¼ inches, while the second spots were correspondingly advanced.

A peculiar thing about these spots was that in every case, the first spot, whether 1½, 3¼ inches, or any intermediate distance from the end had 34 marks around the circumference; i.e., the bar had made 34 vibrations during one revolution. The second spots had 47 marks and the third 51. No relation could be discovered between the time vibration of the bar, speed of rotation and number of these marks.

The experiments on chatter were not carried out as fully as desired, owing to press of other duties. It furnishes an interesting field of investigation for those who like to know the "whys and wherefores" of things, but it is questionable whether further experiment would lead to any practical results.

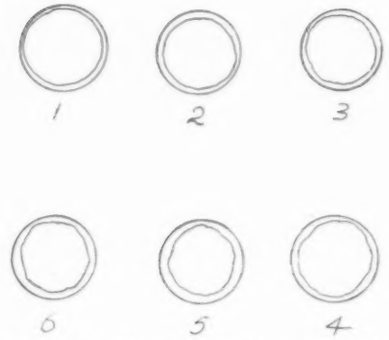


FIG. 9. EFFECT OF INCREASED FEED AND RADIUS OF TOOL POINT

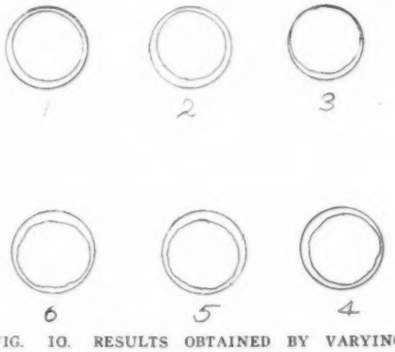


FIG. 10. RESULTS OBTAINED BY VARYING FEED ALONE

Conclusions

1. The smaller the area of cut, the more nearly round will the work be.

2. There is no advantage as far as roundness goes, in using a fine-pointed tool. All elements entering the problem are against it, except that of chatter.

3. A tool without side rake is best for finishing cuts. While it shows a slightly greater tendency to chatter, this is more than offset by the better surface left by the tool.

4. The larger the radius of tool point, the greater tendency to chatter.

5. That, taking into account the tendency to chatter, life of tool, kind of surface left by the tool, and roundness of work, a tool with no side rake, and having a point of 0.075- to 0.10-inch radius is best for finishing cuts on light work; back rake to be given to suit the material.

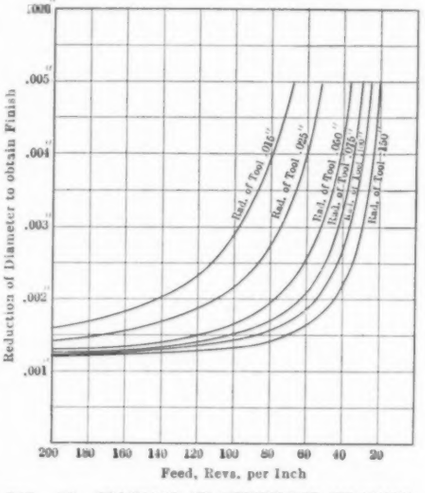
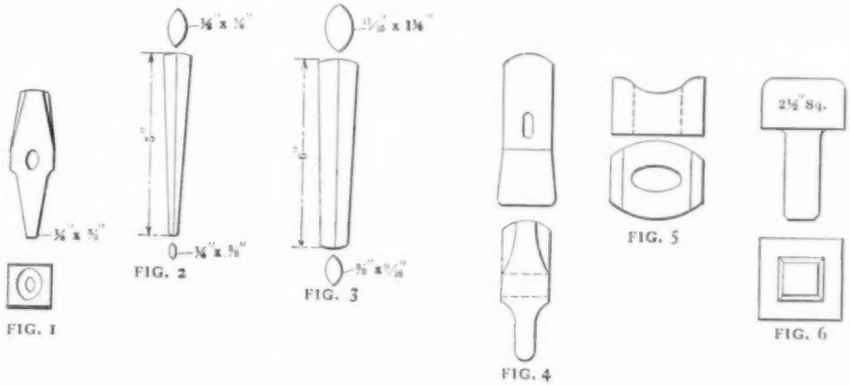


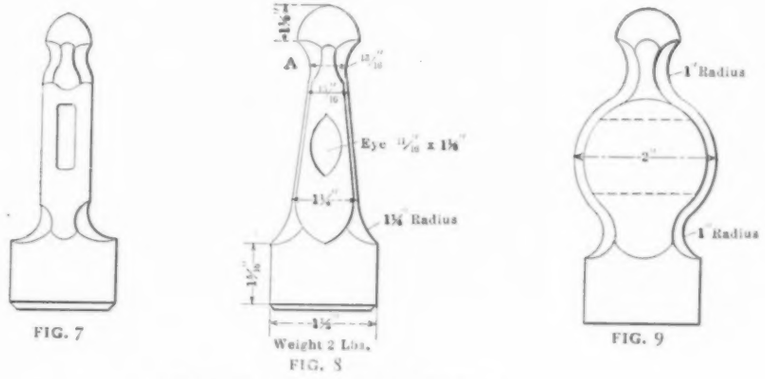
FIG. 11. DIAGRAM OF REDUCTION IN DIAMETER NECESSARY FOR FINISHING

Making a Well Shaped Hammer

By T. Thoms

It is a hard matter to find any mechanic who prefers a factory or machine-made hand hammer, to the hand-forged article, made by a tool smith who thoroughly understands the making of one. Of course, every tool smith does not get his dimensions just right, if he did, this article need not be written, but as most every smith takes a just pride in forging and finishing a well proportioned hammer it is my desire to show what tools are required and the proper dimensions for an average light and heavy hammer.





MAKING A WELL SHAPED HAMMER

The first requirement for a good hammer is, of course, a good grade of tool steel, adapted to withstand impact, heated slowly and thoroughly and annealed when finished, as this is one cause of so many hammers breaking through the eye or the peen jumping off, owing to the uneven strains of forging being still there when tempered.

An oval eye is much stronger and can stand harder usage than a flat sided eye. The mandrels shown at Figs. 2 and 3 can be used for one- to three-pound hammers, the latter size being considered as a flogging hammer, and is seldom used.

The eye punch, Fig. 1, is also oval and smaller than is usually made for this purpose, the object being to start the eye small and keep forcing the mandrel in as the eye is spread, thus avoiding any possibility of a cold shut. When new at the business, I used square steel, but soon found the outside skin of the eye overlapped the inside in spreading and made a very bad job, therefore, I cut the square to an octagon and by so doing the inside kept pace with the outside and makes a first-class eye in every way.

The spreading tool, Fig. 4, is very handy and is almost a necessity as one can spread the eye in any direction one's judgment dictates. This tool should have no sharp edges to cut in and work into the steel or to leave marks on the finished eye, and should be polished to do a smooth job.

Fig. 5 is a tool that needs no explanation as most every tool smith has use for them to drive the mandrels through the eye, however, as this article is for young heads as well as old, I may say that a 1½-inch hex nut is just right after closing slightly and sinking in a piece of smooth 1¾-inch round steel about ⅜ inch and driving the larger mandrel through for the eye.

Fig. 5 is a bottom tool to spread the eye on, and will be found convenient in keeping the hammer in line, as the peen being slightly larger than the top of the eye, it is forced from one side to the other, if worked on the anvil. A set of ¾, 1 and 1¼-inch top and bottom fullers, and a set of 1- and 1½-inch top and bottom swages completes the kit.

We will now proceed to build a hammer that will outlast any ten factory-made hammers and be ready for use in thirty minutes after annealing. For a 1½-pound hammer, 1⅜-inch hexagon and for a 2-pound hammer 1½-inch hexagon steel is required. I square the end and measure with my calipers 1½ inches back on both sides and center them. I then punch the hole as *straight as possible*, driving the punch through no farther than needed to start the small mandrel. I then fuller just at the edge of the eye with ¾-inch top and bottom fullers until the stock at *A* measures 1 1/16 inch, and proceed with the face end the same, but sink the fuller just enough to make a good mark.

I then spread the eye using the small mandrel until it goes through, being very careful to drive it in repeatedly as the sides are spread. I now round the eye and work the outside edges, so it is not quite a perfect circle.

The larger mandrel now is used, also the tool, Fig. 6, and round-edge flatter, driving the mandrel as the eye enlarges. If the circle doesn't come out as it should, I spread lightly with the tool, Fig. 4; if too much, work around with the round-edge flatter until the dimensions shown in Fig. 7 are obtained, or slightly larger, as the surplus can be ground off. In doing this work, keep all scale off the bottom tools and use plenty water.

Finish the neck on the peen end with 1-inch fullers, working the steel just at a red heat and no more. Reverse and finish the face end the same as the dimensions given in Fig. 7. Swage the face end with just a slight taper and cut off as smooth as possible; reverse and swage the peen and cut off ¼ inch from the fuller marks, using a sharp angle for the cut.

Work the peen so it will form a 1-inch ball slightly high in the center, being careful all flat spots are worked out. Go over both necks with the fullers, using a low heat and plenty of water to get a polish.

Do the same with the sides of the eye, being sure they are straight and in perfect line. If the fuller marks are deeper on one side, place the shallow side on the bottom fuller and strike a sharp blow on the top side of the eye until it lines up. When smoothed and lined as perfect as possible drive the finishing mandrel in the eye so one side is *slightly* larger than the other; this forms the outside or wedge side the whole width of the eye and allows of two long, thin wedges being used and keeps the handle always tight if the wood has been seasoned as it should.

Take a thorough slow heat (a cherry red, no more) and put in the lime, dry, fine ashes, or charcoal dust, and leave until cold, after which go over with a half-round file so that all the fuller marks line up as they should and the sides of the eye are smooth and all lines are distinct and clear. For tempering, heat to a cherry red, and dip the face first, being careful to move around to avoid a water line, then reverse quickly and dip the peen and polish the face while the peen is cooling, leaving the eye to draw the temper

in both face and peen. Let the color run to a deep purple and cool slowly in oil, keeping the eye as soft as possible. When cold, polish on a buffing wheel.

As the life of a hammer depends in a measure on the heating, a few words about this and I am done.

It is a well known fact that more tools are ruined by overheating than by hard usage, and as all steels will stand a much higher heat with less injury by heating slowly, it is well to keep this in mind in making a hammer and prepare a good, hollow fire that will heat your steel equally on all sides.

There is no tool I know of that has to stand such unequal strains as a hard-worked hand hammer in the hand of an energetic worker, therefore it should be heated, worked, annealed and tempered more carefully than the average tool.

Fig. 7 shows the sides of the eye choked in on the mandrel which, with the common shape of mandrel used, gives a very weak side, while the graduated taper of Fig. 8 and the oval mandrel with the proper tempering makes an exceedingly strong shape and at the same time pleasing in appearance. It may be thought somewhat difficult to keep the taper thus shown when forging, but it will be found easier and far less work than getting the stock down to shape in Fig. 7.

Some Interesting Shop Tools and Methods

The shop of the Wells Bros. Company, Greenfield, Mass., contains some very interesting examples of concrete construction, among them being the method of mounting the row of milling machines, shown in Fig. 1. These are small special machines for fluting reamers and similar work and, as will be seen are all mounted on a continuous concrete support. Behind them is the shaft which drives the whole row, but each is independently connected by a friction clutch and controlled by the shifting lever shown by each machine. Lubricant is pumped from the main supply up through the pipe at the end of the concrete framework and delivered to each machine as wanted. The drip from each machine is connected to the inclined pipe shown in front of the bench and goes back to the lubricating system, all pipes being concealed in conduits, covered with iron plates so as to be easily adjustable.

There are a number of other interesting applications of concrete in this plant, such as a huge base for the chimney, which, in order to be in the desired position had to span a small stream. Then there are benches made having concrete supports similar to those shown in Fig. 1, special benches in the shipping room in the shape of solid blocks of concrete. The hardening room, whose windows are small and next to the floor, has a thin concrete wall about three feet high and perhaps two feet from the windows in order to prevent any direct light and also to de-

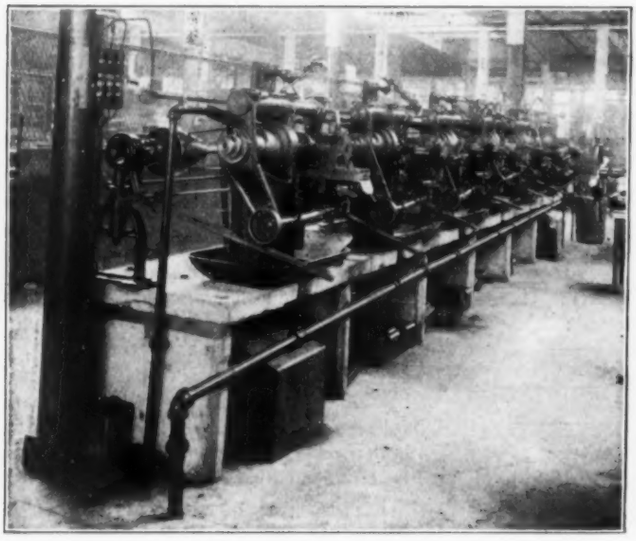


FIG. 1. CONCRETE BENCH FOR MILLING MACHINES

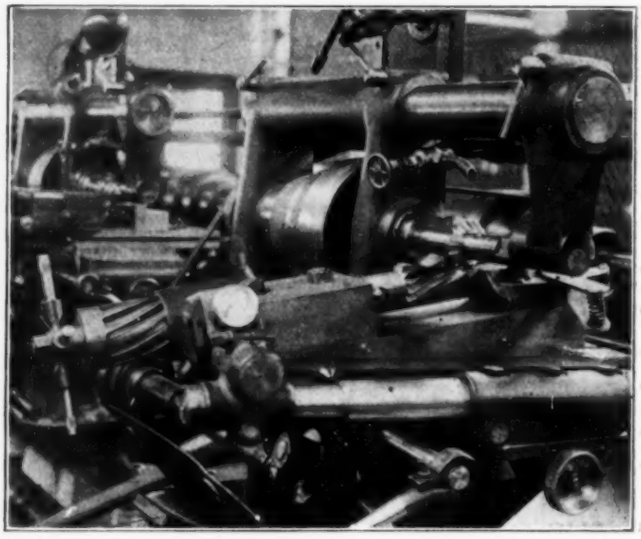


FIG. 2. FLUTING A SPECIAL REAMER

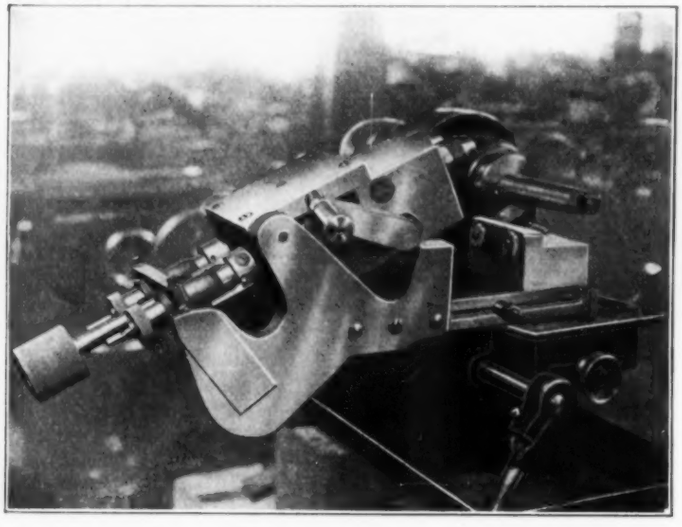


FIG. 3. FIXTURE FOR FLUTING LONG TAPS

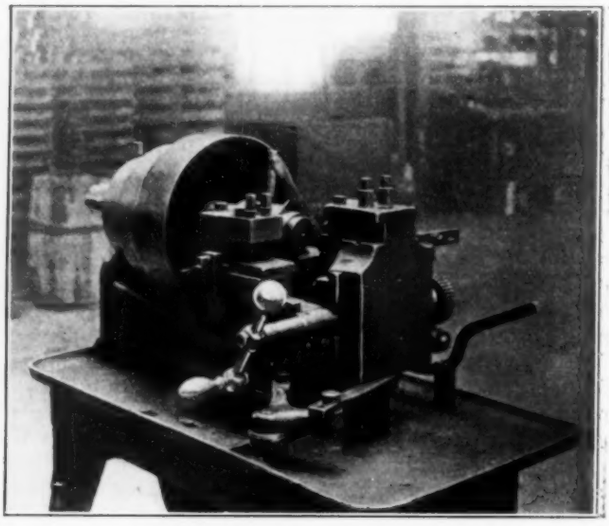


FIG. 4. SPECIAL LATHE FOR FACING AND TURNING AT THE SAME TIME.

flect the air upward, making a rather unusual application.

A closer view of one of these machines shows how it is rigged up for fluting a special form of reamer. The work is held between centers on the inclined table and the shapes of the flutes are determined by the former shown very clearly at the back. This also indexes the number of flutes, being made especially for this class of work.

Another interesting milling-machine fixture is shown in Fig. 3, which is a new device for holding long taps to be fluted. In the position shown, the fixture has been tilted up so as to allow the long tap shanks to be inserted in the chuck. After this has been done, they are brought to a horizontal position when the chucks automatically close on the shanks and the outer ends of the taps are supported in the centers shown.

These centers are worthy of careful notice and consist of hardened-steel disks with a projection on one side and a depression on the other. In the position shown, the depression or female center is in position to support the outer end of the taps, but by loosening the central screw, this can be reversed and the male center brought into position for use. In either position they are very rigidly supported and give a very substantial backing for the taps being fluted.

The chuck jaws are controlled by the clutch lever shown at the back, these being acted upon by spools controlled by the yoke which is shown just entering the angular slide at the back. In this position it has just begun to withdraw the spools and a little further movement releases the clutch lever and opens the chuck. When the fixture is thrown down into position, this action is reversed and the chuck jaws act on the work as soon as the yoke leaves the angular slide at the back. The crank handle shown at the side on the incline portion of the figure is for indexing the taps so as to bring the flute in the proper position. One turn of this handle revolves the work one-quarter of a revolution. Altogether it is an extremely interesting fixture and one which enables work to be handled very rapidly.

In Fig. 4 is an interesting type of special lathe which was designed many years ago to face and turn at the same time. The work is held directly on the lathe spindle and a tool placed in each tool post or carriage. These move at right angles to each other and operate both sides at once, through the bell crank in front. The feed is through the worm and wheel shown at the back, the worm being moved in and out of mesh by the lever in front of it. The cross slide is moved positively by the screw, either by hand or power, and the motion communicated from this to the other two.

Another novel feature is the handle shown just above the nose of the spindle. This carries what may be called a half-washer and consists of a steel plate with a half circle cut out of it, the same diameter as the spindle of the lathe. While the work is being turned, this acts as a thrust collar, but after it is finished and while the two are being run back to the starting point, this thrust washer is pulled out so that the work moves away from the facing tool enough to avoid the mark usually made on the return of the tool.

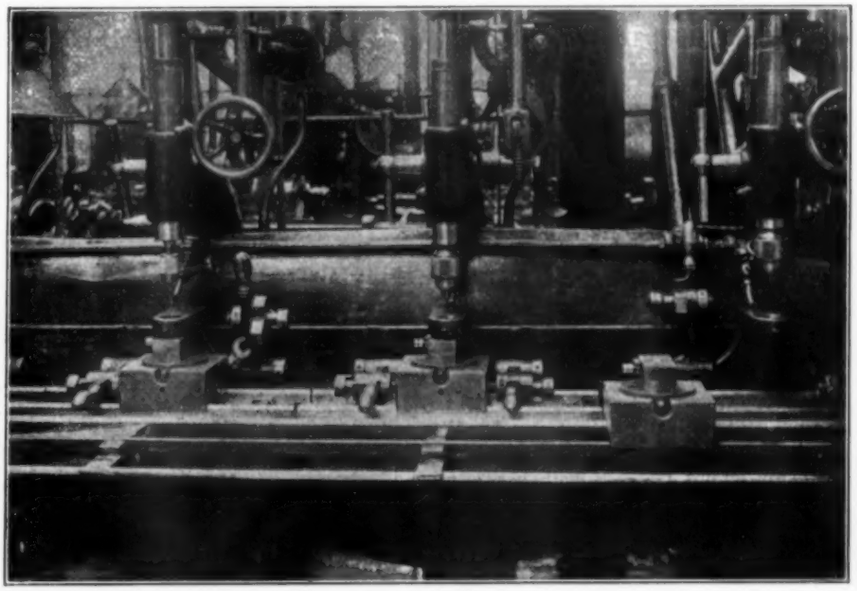


FIG. 6. SPECIAL DRILLING FIXTURE

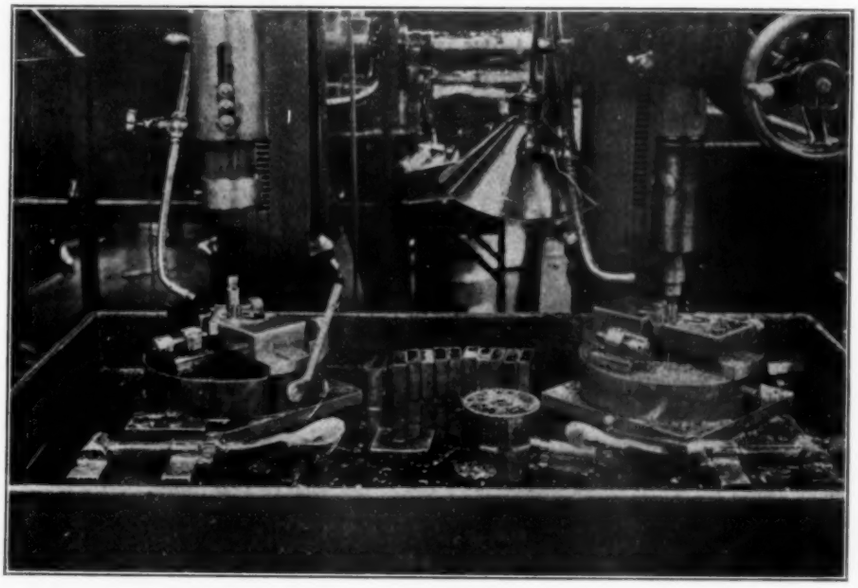


FIG. 5. TAPPING OUT DIES

DRILL-PRESS WORK

Fig. 5 shows two very interesting drill-press applications, the former showing how the extreme friction of a long feather in a telescoping spindle has been overcome. The work shown is tapping out solid dies and it was desired to allow the spindle to follow the tap, being drawn in by the lead of the thread. The friction, however, of the ordinary feather interfered with the lead considerably and to overcome this the method shown was devised.

This may perhaps be called a roller key and consists of three hardened-steel rollers on each side of the auxiliary spindle, these allowing the thread to draw it down out of the outside sleeve without difficulty, even on fine pitch thread. This also shows some very neat chucking devices for holding the die to the tap consisting of a base carrying a special two-jawed chuck, the base itself being locked into position by the handle shown in front. In addition to this, the square corners of the die are held in steel jaws made by cutting away one-quarter of a cylinder. These not only hold the work very securely, but also allow for any slight inaccuracy in the angle of

the corners of the die, each jaw being free to turn so as to grip its corner squarely without throwing it out of center. It will also be noted that the drilling table consists of what is practically a large pan so that lubricant may be used freely without danger of running over the floor.

Jigs on Tracks

Fig. 6 shows three spindles of a four-spindle drill arranged for special drilling also on die work. As will be seen, this is a double-track table, one track being directly beneath the drill spindle and the other in front of it. The dies to be drilled are held in the special chuck shown and the bases of these are grooved to correspond with the track, there being a V at the back and flat in front.

The first spindle at the left has the work in position under it ready to be locked in place as soon as the handle at the right has been dropped as shown under the middle spindle. The stop-screws shown in each of these handles bear against hardened blocks in the base of the work chuck and a tongue on the front of the lever drops into a corresponding notch beside the outer track so that the lever is securely held without putting any bending strain on its support at the back. One of the stop-screws of each pair has a micrometer adjustment so that the hole can be located with extreme accuracy, and in this particular case a large hole was being drilled in the center and a smaller one at each side of it. After the stops are set the chuck and its base are slid from one spindle to the other with the assurance that the holes drilled will always come in the right position and allowing two or more drills to be in operation at once. As soon as the last hole is drilled, the chuck is lifted over onto the front track and slid back to the beginning, being unloaded in the meantime and a new piece of work put in place.

Tool Storage

Mr. Wells has given a great deal of attention to such details as the safe and convenient storage of tools and Fig. 7 shows his method of storing milling cutters. It is somewhat unusual to find tool closets with glass doors, but these are the kind that are being installed at this shop as fast as possible, one of them being shown in Fig. 7. The illustration only shows the upper part of the structure, the lower portion being devoted to drawers for other purposes. The shelf formed in front of the glass doors is covered with linoleum and has light channel iron around its edge.

As will be seen, the cutters are kept on wooden pegs, four of these being mounted in a wooden block of convenient size for handling. These closets are being made of a standard size and these blocks can be used on any shelf and in any order that may be desirable, as each forms an independent unit which can be indexed or classified as may seem best. And if it should seem best at some future time to entirely change this classification or arrangement, it is only necessary to shift these blocks in any way you desire, the closets remaining as before. This has the advantage of keeping cutters away from the dirt, of having them readily accessible at all times and of being able to see almost at a glance, or at least with the minimum of effort, just what is in stock. Grinding wheels, and in fact any similar tool which lends itself to this treatment, are being stored in the same way which is proving very satisfactory.

In the other furnace used for small work, the heating chamber consists of a series of 1¼-inch tubes around which the heat passes heating them to the desired degree. The work to be heated is arranged in half trays, made by cutting iron pipe in half and pushed into these tubes in the furnace itself. In this way they are surrounded by the heat and are heated with extreme uniformity, being quenched in brine as is usual with tools of this kind.

In the endeavor to avoid duplicate work or unnecessary handling of either orders or material, a form of order blank that has been devised to take care of special work is interesting as being a step in the right direction. This portion of the order blank is divided into sections, one being allowed for each operation. By doing this, it is only necessary to write in each place whatever special instructions may be necessary for the work in hand and none of the other departments need to know anything about the rest of the work. If there are no instructions under the head of "Threading," or "Fluting," the men in those departments know at a glance that there is nothing unusual in this part of the work and they pay no attention whatever to the special instructions for the other departments.

FIG. 7. METHOD OF STORING MILLING CUTTERS

Gaging Heats for Hardening Carbon Steel

By James Cran

This subject has been freely written upon and discussed; still some of the most essential information upon the gaging of heats seems to me to have been omitted.

Writers almost invariably give the temperature, either Centigrade or Fahrenheit, to which carbon steel should be heated before it is quenched. This is all very well as far as it goes, and would be easy to put into practice, providing every steel worker and hardener was supplied with the right kind of heating appliances, together with pyrometers, thermometers and other accessories that would enable him to gage heat to any degree. But it must be borne in mind that even in this age of advance and scientific research, the only hardening equipment of numerous concerns which are otherwise uptodate is the forge fire and a bucket of water.

Hardeners who, of necessity, must use primitive and obsolete equipments, of the kind mentioned, are very little benefited by what is generally written upon the subject, and have to gage or rather guess at the proper temperature by the appearance of the piece while it is being heated.

It takes a man of experience to gage heats with any degree of accuracy at all times, and under all conditions, without getting some pieces just a little hotter than they should be for the best results. This may mean the spoiling of expensive tools upon which weeks of labor have been spent. A bright or a dull day makes a considerable difference in the appearance of heats and sometimes the eye of the most experienced hardener gets off color, even were it possible to harden all grades of steel at the same temperature.

Effect of Carbon Content

The heat at which a piece of carbon steel should be quenched, for the best results, depends entirely upon its carbon content. Steel containing a high percentage of carbon requires less heat than that containing a lower percentage.

Carbon is diffused throughout the metal in two conditions, namely, carbide and hardening. When a sample of soft, or annealed steel is examined, the greater part of its carbon content will be found to be in the carbide form. If the sample is heated to the proper temperature and quenched it will be found upon being tested that the carbon content has changed from the carbide to the hardening condition. In steel that has been tempered the carbon will be found in both conditions, varying with the temperature to which it has been heated in drawing the temper.

As nothing is added to nor taken from steel in hardening the change can only be in a rearrangement of the constituents already present in the metal. At the temperature at which this rearrangement occurs steel loses its magnetic properties, and is in proper condition for being quenched. The exact temperature at which the carbon content of steel undergoes this change of form is generally termed the point of recalescence.

Use of Magnetic Needle

This point can be determined by the use of a magnetic needle, or horseshoe magnet. Of the two, the magnetic needle is preferable, as it is much more sensitive than a magnet and less trouble to use. An ordinary pocket compass, which will cost from $1.50 to $2.50 is all that is required. By its use every piece to be hardened can be tested and quenched at the proper temperature, regardless of light conditions or environments.

In using a compass to gage heats it should be placed on a small bench of wood, or some other nonmagnetic material, near where the steel is being heated. It should be in a position that will allow the piece to be hardened being moved backward and forward, within a short distance of the compass, and on a plane with its needle. The needle will then be attracted by, and follow the motion of the piece, until it has been heated to the point of recalescence.

The safest plan when using a magnetic needle to gage heats, is to heat the work to be hardened as uniformly as possible until it is approaching what is generally known as cherry heat, or dark red, then trying it by moving it backward and forward on a plane with the needle. If the needle is attracted, heat the piece a little higher and again try it, repeating this until all attraction has ceased and the needle remains perfectly still. This proves that the steel has lost its magnetic attraction, or reached the point of recalescence, and is in the right condition to be quenched for the best results.

Gaging Heats

Once the proper heat, for any grade of steel, has been ascertained, it is an easy matter to gage it very closely by the color, it being necessary only to try a piece occasionally when the light or other conditions leave any doubt as to the proper temperature.

This method of gaging heats applies only to such pieces as have to be hardened all over, as it is obvious that the heating of such tools as drills, reamers, taps and similar pieces, that are only hardened on their working parts, would have no disturbing effect upon the needle, as only part of them would be hot enough to have lost the magnetic attraction.

Tongs used to handle pieces to be hardened all over affect the needle more or less, and it is advisable to use a hook to handle the work with, while hot. This hook should be as near as possible to the same temperature as the work to be hardened. After the heat has been tested work can be transferred from the hook to tongs, for the quenching.

What would overcome the whole difficulty would be to have a pair of tongs, of the pick-up type, made of brass, as this has no magnetic attraction whatever, or the tongs could be made of nickel steel for the same reason.

When hardening reamers, taps, or any kind of tools that are only to be hardened on certain parts, a test piece of the same grade of steel should be used. The color can then be noted that gives the right temperature and the heats gaged from that.

Forge Fire for Heating

The heating of carbon steel in the muffle of a gas furnace or lead pot is too familiar a subject to need further explanation here, but heating with a forge fire for the best results is entirely different, and much more difficult, especially if the work to be heated is of large dimensions. The side next to the blast heats faster than the side away from it, thus calling for constant turning and attention in getting it to anything like a uniform temperature.

It is next to impossible to heat long slim pieces with any degree of uniformity, however careful the hardener may be; still the forge fire can be and is used very successfully to heat, for hardening, such pieces as are not likely to warp, or get distorted, by their own weight while hot.

A hollow fire is best for the purpose, and can be prepared by placing a wooden box or frame over the center after the fire is lighted, and packing fine green coal that has been dampened on the sides, back and top of the box or frame. Then by turning on the blast just enough to keep combustion going until the wood is reduced to ashes, it leaves a hollow fire, well charred inside. An opening in this should be made, sufficiently large, to allow of turning the work while being heated.

Oxidization or Scaling

A bed of well charred coke, several inches in depth, should be preserved between the blast and the work, and over this a layer of wood charcoal may be used, as it has a natural tendency to counteract the influence of oxygen, that is supplied through the blast, and prevents overoxidization, or scaling.

The opening in the front of the fire may be closed with a piece of sheet metal, with an opening in the center, through which the heat can be watched, and the work turned.

When the number of pieces to be hardened are such as will justify going a step farther, the sides, back and top of the fire may be inclosed with brick. This makes an improvised furnace, with which very satisfactory heating may be done, by placing a piece of boiler plate over the bed of coke, thus converting the space between the boiler plate and the top of the furnace into a muffle similar to that of a gas furnace. The opening in the front should be just large enough to admit work and keep up the fuel supply, which can only be done by raising the boiler plate.

Overheated Steel

The greatest drawback with fires of this kind is that they cannot be maintained, for any length of time, at an even temperature, and, therefore, require constant attention. Should a piece of carbon steel in any way get a little overheated, it should be allowed to cool down slowly until it can be handled by hand. It may then be reheated to the proper temperature and hardened without any deteriorating effect upon the tool.

Carbon steel that has been scorched or burned can be restored to a certain extent by heating to a bright yellow and placing in a mixture of finely powdered wood charcoal, rosin, fish oil, and tallow mixed in equal quantities to the consistency of paste. Steel treated in this mixture should be allowed to cool down before removing from the fire. When fairly cold it can be forged or annealed and worked into tools that compare well with tools made from steel that has been carefully handled.

Tools for Milling Turbine Buckets

A Rotary Milling Fixture, Special Cutters and Cutter-Driving Device Permit the Cutting of a Complete Disk in Thirty Minutes

BY WILLIAM E. SNOW

With the rapidly increasing popularity of the steam turbine there has come to the manufacturer the problem of handling this new type of engine in shops not well equipped, at best, for the high-grade nozzle and bucket work demanded. With bucket wheels of the built-up type, where each bucket is a separate piece, the bucket can be either drawn into bars, or stamped out in dies at a small expense, but with the solid type of wheel the case is different. In this latter type of turbine the buckets are out in the periphery of a large forged-steel disk, and the task is by no means an easy one to accomplish successfully.

A particularly difficult problem of this kind arose when it became necessary to manufacture some turbine wheels containing buckets of the German type, as originally exploited by Messrs. Riedler and Stumpf. Referring to Fig. 1, which shows this bucket in detail, it will be seen that it consists of a semi-circular pocket set at an angle of 20 degrees with the wheel's

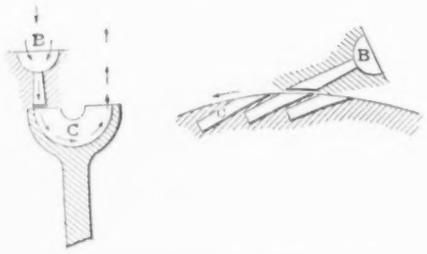


FIG. 1. DETAIL OF TURBINE BUCKET

periphery. There were 38 of these pockets in each wheel. Fig. 2 shows the forging in the periphery of which these buckets were to be cut. In order to facilitate this operation forgings of soft, open-hearth steel of very even density were obtained. These forgings were 30 inches in diameter and weighed 250 pounds each.

The Rotary Milling Attachment

Milling was suggested as the easiest and, in fact, the only practical way of executing this work, and it was accordingly adopted. A vertical miller with a bed of sufficient size to readily handle the 30-inch bucket wheel was selected. This miller was equipped with automatic feed and micrometer indexes for fine adjustments in three directions. The first step was to fit up a suitable rotary attachment for carrying the bucket-wheel forging and accurately spacing the 38 buckets. This rotary attachment, as seen in Fig. 3, consisted of the cast-iron spider *A*, provided on its circumference with a number of suitable bosses *B*, to which the bucket wheel was securely bolted. An arbor *C*, which neatly fitted the bore of the bucket-wheel hub, was provided in the middle of the spider, thus accurately centering the bucket wheel on the fixture. A steel band *D* was fitted snugly around the circumference of the spider and 38 accurately spaced notches corresponding to the number of buckets in the wheel were cut in it on an automatic gear-cutting machine.

The Rotary Milling Attachment

A suitable base *F* of cast iron was provided to support the spider. The arbor *C* was seated in the bushing *G* in the base, permitting the spider *A* to be rotated

FIG. 2. DISK IN WHICH BUCKETS ARE CUT

FIG. 3. THE ROTARY BUCKET MILLING ATTACHMENT DISASSEMBLED

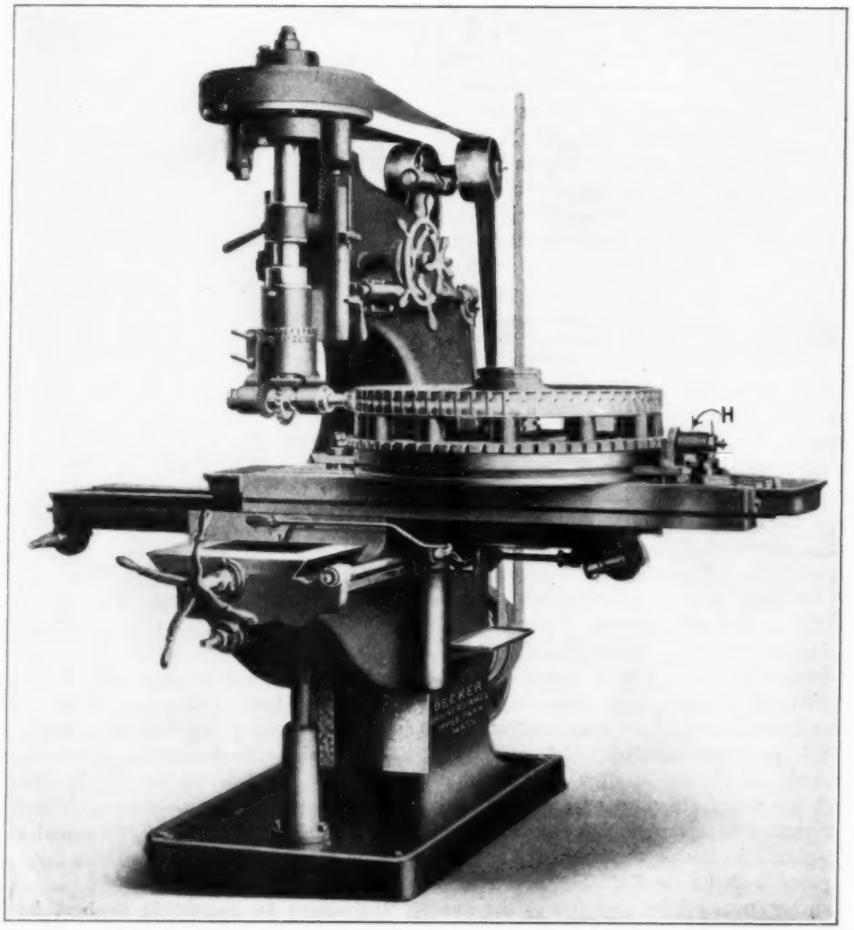


FIG. 4. ROTARY BUCKET MILLING ATTACHMENT ASSEMBLED ON A VERTICAL MILLER

accurately on its center. A detention pin *H*, Fig. 4, was provided for securely locking the spider in place in its 38 positions by engaging with the notches *E*. This pin was held firmly into the notches by means of a spring and was provided with a quick-thread screw to facilitate disengagement by a couple of turns with the hand. Fig. 4 shows the complete rotary

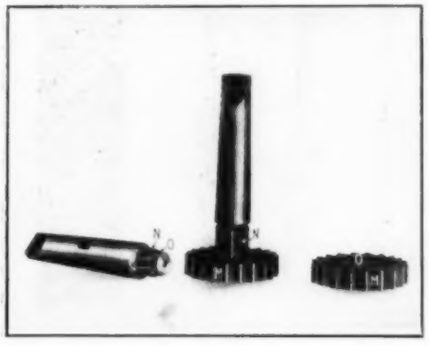


FIG. 6. CUTTERS USED FOR MILLING TURBINE BUCKETS

attachment assembled on the miller with the bucket wheel in place.

As the ordinary vertical cutter on the miller could not be used for this work it was removed and a special attachment fitted instead. The details of this attachment are shown in Fig. 5. The regular cutter was replaced by the arbor *I*, equipped with a bevel gear arranged to mesh with the bevel gear on the shaft *J*. The end of this shaft was in turn fitted to receive the arbor of the cutter *L* secured in place by a set screw.

The Cutters

The cutters for this work were 2½ inches in diameter by ½ inch thick, and as they had to cut on top, bottom and sides of the bucket at the same time the work was unusually heavy—so much so, in fact, that grave doubts were felt as to their ability to endure the strain. At first two sets of cutters were used, the finishing cutters being 1/16 inch larger all around than the roughing cutters. Fig. 6 shows a set of these cutters, and it will be seen that in addition to the main cutter *M* the arbor is provided with a smaller cutter *N*. The buckets being in the form of an exact semi-circle it was necessary to provide the cutter *N* to clear a sufficient working space for the main cutter *M* as it reached the full depth of the cut.

To facilitate the tool work on the cutter the large cutter *M* was made separate from the arbor *O*, which was screwed into the cutter disk so as to be easily detachable. This construction permitted the use of high-speed steel in the main cutter without the expense incidental to making the arbor of the same material. The arbor and small cutter were made of an ordinary grade of carbon steel. As these cutters were frequently broken when encountering hard spots in the bucket-wheel forgings this saving in cost was an important item.

Operation of the Fixture

The automatic feed on the miller was found to be too rapid for this class of work, so a different set of belt pulleys were substituted to obtain a slower feed. The average time required for cutting a

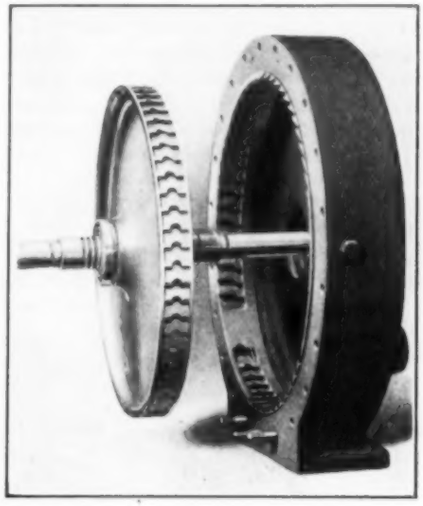


FIG. 8. A FINISHED BUCKET WHEEL

complete bucket was found to be 20 minutes for the roughing and 10 minutes for the finishing cut. At this rate the cutting of a complete wheel of 38 buckets took a trifle over two days, but one man could easily run two machines on this class of work. A steady stream of oil was supplied to the cutters by means of a small

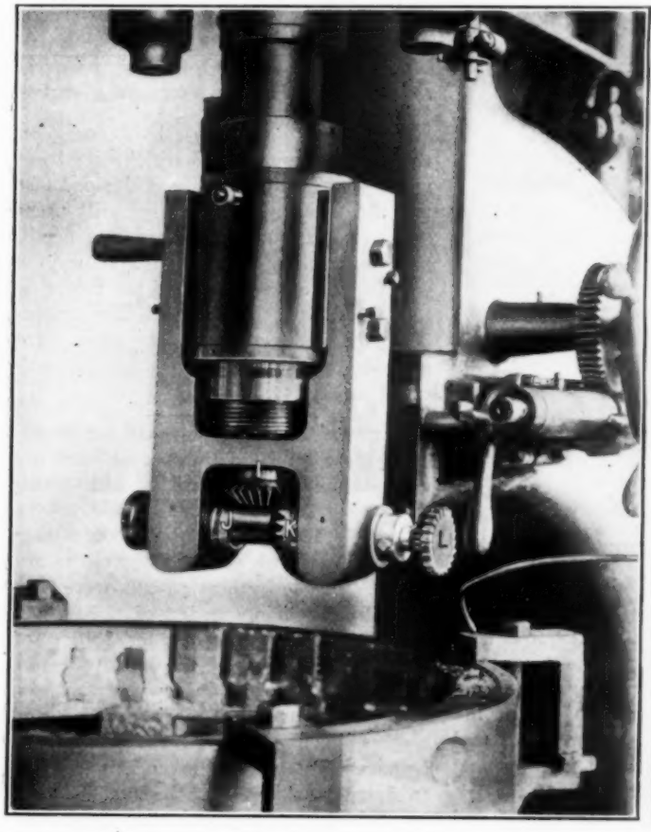


FIG. 5. CUTTER-DRIVING MECHANISM FOR MILLING TURBINE BUCKETS

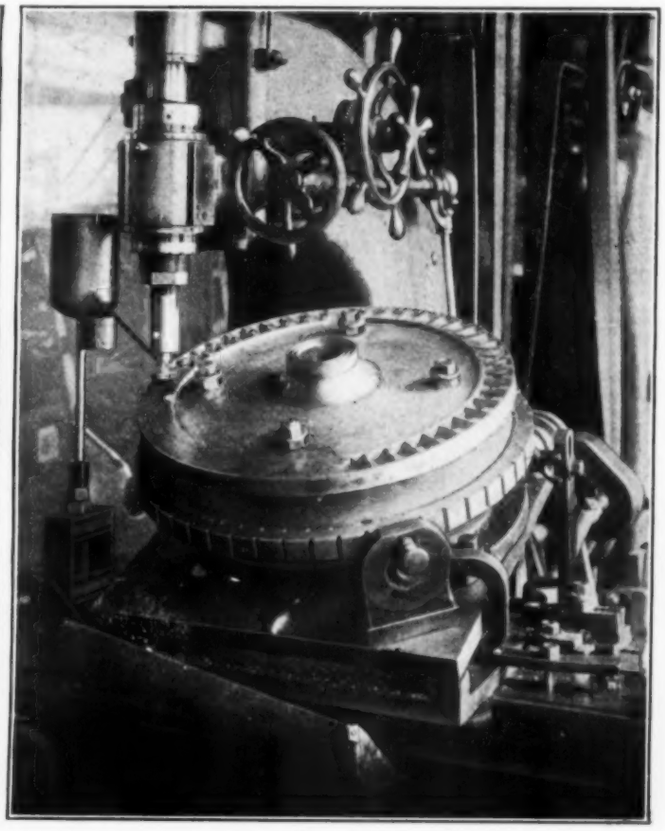


FIG. 7. CUTTERS AT WORK ON A TURBINE DISK

rotary pump, which served the double purpose of lubricating the cutters and washing the chips away from the work. If the chips were permitted to accumulate they invariably got under and scored the surfaces of the buckets. Fig. 7 shows one of the cutters at work in a forging. Fig. 8 shows a finished bucket wheel.

Fig. 9 shows the method adopted for cutting a radial type of bucket. In this case the rotary attachment *A* which carries the bucket wheel is placed upon the tilting support *B* and set at the required 20-degree angle by means of the distance piece *C*. The special attachment, shown in Fig. 5, is not required in this case, as the cutter can be placed direct in the head of the miller in the regular way.

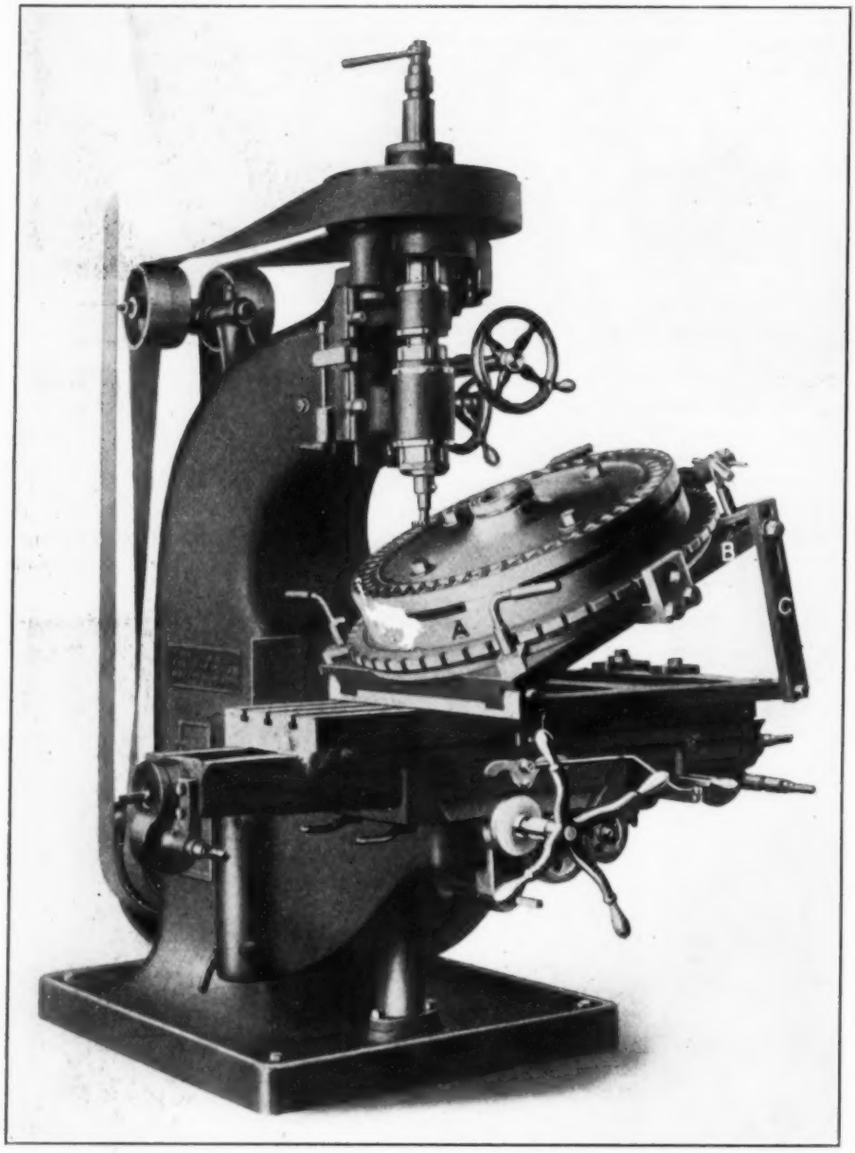


FIG. 9. ROTARY FIXTURE SET TO CUT A RADIAL TYPE OF BUCKET

The above apparatus has been in constant use for the past four years, during which time hundreds of bucket wheels, ranging in size from 15 to 36 inches diameter, have been satisfactorily cut at very moderate cost. It possesses the further advantage that should the miller be required for other work at any time it is a very easy matter to remove these simple fixtures and re-transform it into a plain milling machine again.

Device for Accurately Locating and Drilling Holes

By W. E. Barnard

The tool shown in the illustration herewith will be found valuable, especially to those who work on flat metal. It is possible to drill a hole within one-thousandth of an inch with the device. Fig. 1 shows the four parts necessary to obtain the desired results. The jig is made of tool steel, hardened and ground, the bushing being square with the bottom of the jig. The bushing is hardened and ground and the hole lapped out 0.125 inch. The centering gage and spotting tool are hardened, ground and lapped to fit the bushing. In using this device the first thing to do after center-punching the place to be drilled is to place the jig on the piece and insert the centering gage, bringing the point to the punch mark and while clamping the jig to the work hold down on the centering punch to keep the jig from moving; then after the jig is clamped fast put the spotting tool in the drill press and spot the work to the required depth, finishing with a drill. Fig. 2 shows the jig clamped to the work and the centering tool inserted in the bushing. The centering gage and center punch points are ground down to the same angle as indicated in Fig. 1.

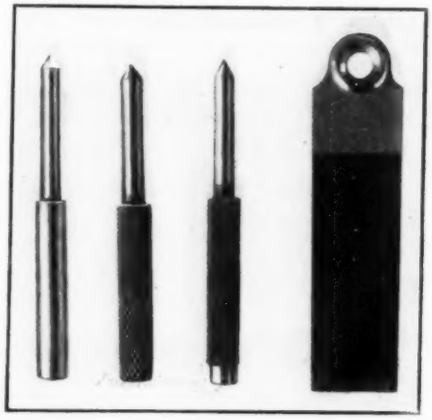


FIG. 1. JIG AND TOOLS FOR ACCURATE DRILLING

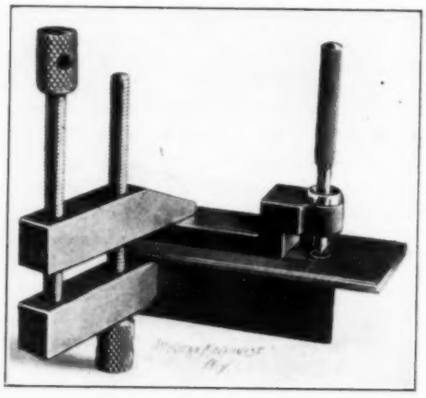


FIG. 2. THE JIG CLAMPED ON THE MACHINE

Inventions by British women are broadening very much in their scope, and are now including many articles with which one would suppose women would not be intimately acquainted. About 600 patents are now granted to British women annually. Formerly these patents were confined to the dainty order of things, but they now cover the broader sphere of mechanism. Some of the more effective recent improvements in sewing machines, automobiles, and even marine engines and motors have been patented by British women. Patents for inventions relating to flying machines have been applied for by British women, and they have also directed inventive attention to railroad cars and to wireless telegraphy.

The Tempering of High Speed Steel

Simple Methods. Barium Chloride, Sand Pan, Metal Baths, Oil Baths and Electricity as Used for Tempering. Degrees at Which to Temper

BY O. M. BECKER

Some allusion has been made to the peculiarity of high-speed steel, that the fitness of a tool does not depend on extreme hardness, but upon the very different property of red-hardness. By virtue of this it resists the tendency to become soft, or rub away under stress, after having become considerably heated, either through the heat generated in working, or through being intentionally heated, subsequent to the hardening process.

Extreme hardness is frequently a detriment to a high-speed tool, since it has, generally speaking, brittleness and internal strains for its concomitants. The latter are set up by reason of the unequal hardening of the interior and exterior portions; and the damage they may cause has been repeatedly referred to. Only small and rather regularly formed tools are measurably free from them after hardening. It has likewise been shown that brittleness is ruinous in tools whose working parts have overhang to such an extent that there is not sufficient backing to prevent crumbling of the cutting edges.

Barium-chloride Hardening

A special method of hardening with the barium-chloride process has been recommended as in large part overcoming this difficulty. Even when this special method is used, however, and always in the case of tools hardened by other methods, it is desirable, and unusually necessary to "let down" this hardness and relieve the strains by tempering.

This treatment can be carried to any desired point and practically all strains relieved, and the toughness of the overhanging portions of the tools restored to whatever degree is required for maximum efficiency. This is determined very largely by the nature and use of the tool, as in carbon-steel tools.

About the only tools which are not benefited by tempering are those of the heavy lathe and similar types, with well supported blunt noses. These are ordinarily set at work without any heat treatment after hardening and grinding.

The tempering here recommended does not correspond precisely to the low-heat treatment of the Taylor-White process, for the temperatures are considerably below the minimum limit of the range recommended in that process. It corresponds almost exactly to the tempering of carbon steels, though the temperatures are, in general, somewhat higher, and perhaps maintained rather longer.

Simple Methods of Tempering

As in annealing and hardening, so in tempering results of a more or less uncertain sort can be obtained with very crude appliances, or perhaps none at all. A forge fire and a nail keg have been used, although such crude apparatus is not at all conducive to accuracy and uniformity in results. The latter was used to provide a rather uniform condition of light by which to judge the colors. In this way a tool-holder steel, such as is used for light cutting, may be heated until it reaches a dark straw color and then cooling in the oil bath, or the air blast, as when hardening. A greater degree of softness is obtainable by allowing the piece to cool in air; and a still greater by raising the temperature until it reaches a greenish tinge, and then slowly cooling. Some tools are bettered by following this treatment by another, in which the temperature is raised to a faint red, just perceptible in the dark.

Judging Colors

Important changes take place in high-speed steels within very narrow limits of temperature, not only within the hardening range, but also within the recalescence and the tempering range. And while the colors, through which the surface of a piece of steel successively passes while being heated, are indicative of the temperatures, it must be remembered that these colors are not only difficult to differentiate, even to keen and experienced eyes; but that the judgment concerning them is easily affected by variations in the light.

The range of colors extends from light straw to purple, or from 425 to 530 degrees Fahrenheit. It is readily seen therefore, that exceeding care must be used in tempering to obtain just the required temperature and no higher. In order to do this suitable appliances are requisite, and trying to temper high-speed steel in a forge fire, as a regular thing, is folly.

Tempering with a Sand Pan

An oven furnace can be used with a moderate degree of success, if it be capable of having its temperature regulated with extreme nicety and provided with a pyrometer for gaging the same. This is little cheaper, if any, than the oil process, though it is available where the amount of work is so small as not to warrant the installation of an oil furnace in addition to the general utility oven furnace.

A rather better method involves the use of a metal sand pan heated by a suitable gas or oil burner. This is recommended by several makers of high-speed steel, and gives fairly accurate results when the temperature is carefully regulated by frequent observations of the pyrometer. The pan should be large and deep enough to contain an ample supply of clean and well dried sand. The tools should be immersed in the sand and brought to the desired temperature without trouble, if the pyrometer is frequently read. This method is also very good where there is no pyrometer as the temper colors are readily observed.

Baths for Tempering

Where the tools are small and it is not desired to provide extensive equipment the method can be used that consists of heating the tools in baths which melt at predetermined temperatures. The difficulty of keeping the baths at the melting point makes the method somewhat uncertain for a rise of a very few degrees is sufficient to give a very different result.

Any sort of melting pot large enough to temper the tools in, an alloy that melts at the temperature required, and any suitable fire that can be easily regulated, is all that is required. The tools should be placed in the melted alloy and kept there until completely and uniformly heated. This takes from ten to twenty or more minutes, and depends upon their size and form. They can then be allowed to cool in air.

If the metal does not chill and set around the tool, when it is first placed in the bath, the temperature is too high and should be at once regulated. In order to keep the bath fluid, the temperature should be maintained slightly above the melting point. This should be considered when preparing the alloy suited to the kind of tools to be tempered, and the mixture should be so proportioned that its melting point will be a few degrees below the temperature to be maintained.

It is exceedingly difficult to secure absolute precision in the measurement of high temperatures, and the determination of those rather moderate ones used in tempering is usually attended with more or less uncertainty. Even when the most perfect instruments are used the personal equation of the observer enters into their handling and into the observations.

One disadvantage that very much limits the usefulness of this method is the impossibility of varying the temperature of the bath without keeping in stock a considerable number of alloys.

The following table gives a list of alloys that melt near enough to the tempera-

tures given for all practical purposes. In the case of the linseed oil, however, it boils instead of melts.

Composition of Bath.		Melting Point in Degrees Fahr.	Color of Steel at Temperatures Given.
Lead and Tin			
14	8	420	Very faint yellow.
15	8	430	Faint yellow.
16	8	440	Light straw.
17	8	450	Straw.
18.5	8	460	Full straw.
20	8	470	Dark straw.
24	8	480	Old gold.
28	8	490	Brown.
38	8	510	Brown, with purple spots.
60	8	530	Purple.
96	8	550	Deep purple.
200	8	560	Blue.
		575	Polish blue.
Boiling linseed oil.		600	Dark blue.
Melted lead.....		610	Gray blue.
Melted lead.....		630	Greenish blue.

The designation of colors for the several temperatures given is somewhat arbitrary, for color discrimination again is a matter of personal judgment and experience, as well as of light conditions, as has been already pointed out.

Oil Tempering

A well equipped hardening plant will have a good oil tempering furnace. This consists of a tank of suitable size and form to contain an ample supply of oil, a furnace for maintaining the temperature at the requisite point, and a high heat thermometer, or preferably a pyrometer. As it is necessary to regulate the temperature within a very few degrees, the furnace must be one whose heat can be controlled to a nicety. A gas furnace is on that account preferred. There should be a basket of perforated metal, or of wire netting to facilitate the removal of the tools.

The basket and contained tools may be placed in the oil while the latter is still cold, but it is better to first raise the temperature of the bath to something like 400 degrees Fahrenheit. Since the main purpose of tempering is to relieve strains, it is well to avoid plunging tools into a bath much hotter than this, for to do so would heat the projecting and exterior portions so rapidly as to set up new strains, which then have to be overcome. The gradual heating which allows the heat to penetrate as it rises, softens the exterior portions enough to allow a readjustment of the molecules under stress, while at the same time it leaves the steel less hard and more tough according as the temperature is high or low within the tempering range.

The temperature of the oil bath should be raised to the point requisite to the tools in hand, and these left immersed for some fifteen minutes or more; the time depending somewhat upon their size and shape. Large tools should remain in the bath longer than is necessary for small ones. The latter are not harmed by remaining in the oil, in case it is desirable to temper large and small tools simultaneously. Only tools requiring the same degree of heat can be tempered at the same time. Large tools may be suspended in the bath in any convenient manner. When removed from the bath the tools should be allowed to cool down, in air, without further attention. Large cutters and dies are often left to cool off in the oil.

The oil used may be any rather heavy kind; that best suited being the so-called heavy or black cylinder oil produced from petroleum. Tallow is sometimes used. The former can be raised without trouble to as high a temperature as is necessary in tempering. One variety it is said, can be raised to from 750 to 850 degrees Fahrenheit without difficulty, and this is the temperature at which steel begins to turn red.

Tempering with Electricity

Drawing the temper by the heating effect of the electric current is possible, though not much practiced commercially. This method is useful if the barium process is not available, for hardening cutters that have a central opening and require the body to be tough, with the cutting edges well hardened.

A vise and mandrel suited to the work in hand can be connected to a circuit and resistance regulator, as in electrical hardening. The tool having been slipped over the mandrel, and fitting loosely upon it, the current can be gradually turned on and the heat brought up to the required point.

Evidently the central portion of the cutter is heated first, and also most heated, unless the operation be continued for a considerable time, consequently the outer portions retain their hardness to a much greater extent than the central, and the latter are correspondingly toughened.

It is possible to duplicate any previously adopted degree of temper in tools of the same form and size, by merely using the same current regulation. The process is rather limited in its applications because of the difficulty of accurately determining and regulating the temperature of the surfaces of tools of various shapes and sizes.

This method is an improvement upon the simple and well known expedient of heating tools by the insertion of a hot rod, somewhat smaller than the opening in the tool, and whirling the latter until the desired color appears upon the surface.

Necessary for Tempering

Certain makers of high-speed steel state that while tempering after hardening is desirable in the case of their particular steels, it is not essential. The statement is not sufficiently accurate. Tempering is not essential in the case of any high-speed steel tools of certain classes, or of any class, if only moderately effective work be acceptable. The proper tempering of carbon steel is even more particular than the hardening; and if this is not exactly true in the case of high-speed steel tools, tempering them to suit the requirements of the particular service required of them is highly important.

The failure to get desirable results from the use of high-speed tools can almost invariably be traced to improper hardening, or more likely, improper tempering. It is exceedingly important, therefore, to have at hand suitable data, in order that the proper temper, as well as the proper hardening heat, may be given every tool. Such data have not heretofore been available for general use, each user of high-speed tools having to depend almost entirely upon his own experience and observation.

Some system of recording accurately the treatment of particular tools is absolutely necessary in order to arrive at determinations in the special cases that arise wherever many tools of various sorts are used.

Temperature at Which to Draw Tools

The following data as to tempering tools are accurate for practically all makes of good high-speed steel, and cover in a general way the range of these tools. The temper of high-speed tools is, in general, drawn (when they are tempered at all) somewhat farther than is done with carbon-steel tools.

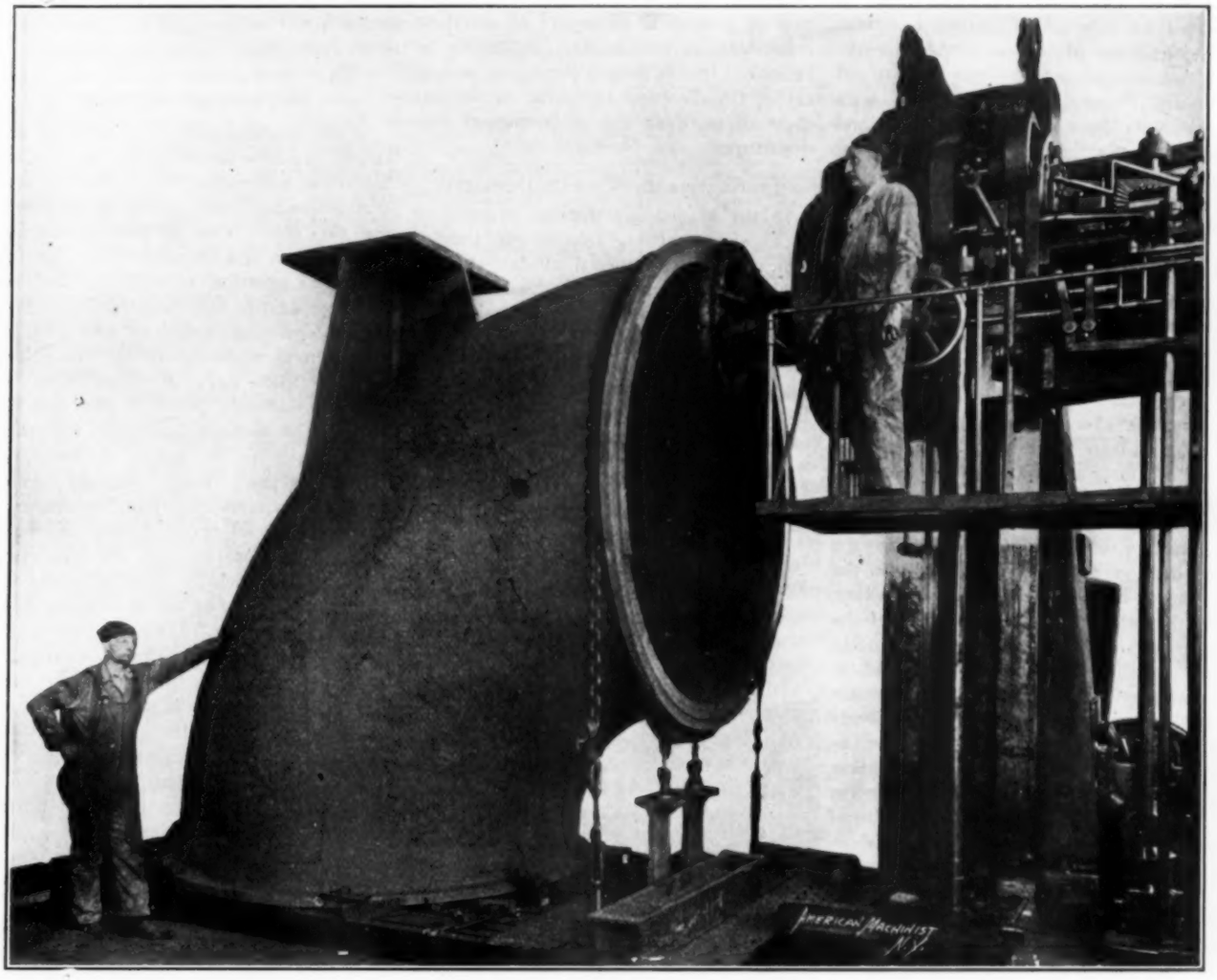
Roughing lathe tools, and all tools for heavy rough cutting, are left untempered. Large reamers and drills with heavy stocks are drawn at 440 degrees Fahrenheit, which is equivalent to a light straw surface color. Ordinary drills, small reamers, and other tools having rather light stocks or bodies and subject to considerable torsional strains, are drawn at 460 degrees Fahrenheit, or a full straw color. Threading dies and taps, 490 degrees Fahrenheit, very dark straw or brown yellow. Ordinary milling cutters and the like, 400 degrees Fahrenheit, or faint yellow. Punches, stamping or cutting dies, and shear blades, 530 degrees Fahrenheit, purple. Chisels, snaps and like tools subjected to sudden shocks, 570 degrees Fahrenheit, or polish blue. Woodworking tools of nearly all sorts, 525 to 625 degrees Fahrenheit, which is from light purple to greenish blue, according to shape and kind of wood to be cut. Brass working should be drawn from 20 to 30 degrees lower than iron- or steel-cutting tools of the same kind.

All navigators will be interested in the news which comes from Liverpool that Sir Oliver Lodge recently succeeded in completely clearing away for a radius of 60 feet a thick fog by means of electrical discharges. The *Marine Journal* states that the Lodge system consists of driving electricity into a fog-laden atmosphere at a very high voltage from a series of disks at the tops of poles. The current acts directly upon the constituents of the fog, the electric influence whirling these hither and thither, causing them gradually to fall to the ground. A test is soon to be made of the apparatus in London.

Machining a Large Elbow

An interesting job by the Buffalo Foundry and Machine Company, Buffalo, N. Y., on the large boring machine built by Beaman & Smith, Providence, R. I., and described on page 242 is shown herewith. The elbow is a steel casting, 8 feet inside diameter, and weighing about 12 tons. In addition to milling the faces, the foot, shown uppermost in this case, was also milled in the same way. This gives a good idea of the size of this boring machine.

After these operations were completed the elbow was turned so that the flanges were horizontal and these drilled for the bolt holes by using a No. 2 Bickford full universal radial drill with a speed box, directly attached to a five-horsepower A. C. motor, with a rawhide pinion and cut gear. The column was removed with its attachments, from the bed of the drill press and bolted to a plate, which was in turn, bolted to heavy bars running across the flange face and bolted to it. The column of the drill was set to about the center of the elbow, and in this way they were able to swing the arm of the radial drill clear around the circle and drill all of the holes without shifting the machine. We regret that no photograph showing the drilling operation was obtainable.



MACHINING AN EIGHT-FOOT STEEL ELBOW

British Industrial Notes

By James Vose

Little of a cheerful character is to be recorded in connection with British industrial matters during 1908. In common with the experience of other countries the boom of the preceding few years culminated toward the end of 1907, and the succeeding contrast was so marked as to lead to a depression of almost unprecedented severity. This involved threatened reductions in wages, which were keenly resented in a number of instances, with resulting strikes and lock-outs of a disastrous character.

Early in the year the shipbuilding industry was disturbed by a strike against reduction of wages on the part of workmen employed in the shipwright departments of the northeast coast concerns, followed later by stubborn resistance to similar reductions by the general engineering branches of the same industry. These disputes were, to the outside observer, conducted more in a spirit of pugnacity than with any real idea of successful resistance, the net result being the practical acceptance of the employers' terms and the inclusion of such branches of trade as the woodworkers, shipwrights, molders, boilermakers, etc., in the terms of settlement imposed by British engineering employers on the operative engineers at the termination of the great strike and lock-out of 1897-8. It may be remembered that these terms left the employers in a much more advantageous position than before as regards freedom in workshop management and the utilization of semi- and full-automatic machines by semi- and quasi-skilled labor, and lowered considerably the potential value and power of resistance to change of men who had previously performed skilled work merely by rote and iteration.

Then, in a falling market the cotton-spinning operatives struck against a 5-per cent. reduction of wages, and after a seven-weeks' stoppage practically acceded to the reduction, and, though some bene-

fit was experienced by the trade in general through the partial clearance of accumulated stocks, the strike like that of the shipbuilding trades, brought incalculable distress in its train to many thousands of helpless noncombatants in the shape of employees of the carrying and distributive interests and the hosts of machine-making and subsidiary industries directly dependent on the working of the cotton industry.

Changes Due to Automatic Machinery

Reverting to the matter of automatic and similar machine-tool manipulation and its effects on workshop procedure and personnel, an aspect, the perception of which is perhaps as yet scarcely adequate, is the tendency of such methods of working to encourage the manufacture of standard designs and productions, with consequent keener administrative and works organization and an accompanying diminution of variety of output. For some time past—practically unnoticed—this tendency has produced such an effect as to have forced itself to the attention of sections of the engineering and metal-working business who formerly considered themselves practically immune from disturbance.

Draftsmen of the routine variety, and patternmakers are now distinctly up against the effects of the changed conditions, and can scarcely fail to find the need of closer association with workmen employed in the heavier and more clothes-soiling departments of engineering. Patternmakers have unquestionably in the past been granted a wider latitude in the matter of choice of methods of working, and the means whereby the ideas of the designer are expressed in actual metal, than the other craftsmen concerned in engineering and machine-making generally. In the nature of things this liberty cannot be altogether withheld even by those who might be desirous of so doing, as the amount of work current in many shops would not justify the installation of special woodworking machinery and labor-saving system devices. But the over-all effect of the multiplication of business making a specialty of patternmaking for the trade in general, and the reduction in the number of designs regularly turned out by manufacturers has resulted in what will probably prove a permanent reduction in the ratio of patternmakers employed in metal-working industries to the whole number of artisans of all the trades employed.

Industrial Training

As in the States, the question of industrial training of all grades of employees in the engineering industry has been prominently in evidence during the year.

It is recognized that many youths have no bent toward the more theoretical aspects of their work, but are still capable of making, within limits, valuable workmen, as they are possessed of energy and a willingness to do actual manual work day in and out without experiencing any feeling of monotony. It is also seen that if such youths are encouraged to acquire the ability to read a drawing, intelligently handle tools, and display punctuality and good, general attendance, employers may well be satisfied. Other classes of apprentices whose predelictions are in the direction of the designing and administrative aspects of engineering, while not released from their fair share of work-shop and routine work, are allowed facilities for the pursuit of their special studies. The results so far are considered worth the trouble involved. Of course, except in the case of individual employers or directors enthusiasm in such matters is scarcely to be looked for, as British employers seldom err in the direction of undue encouragement of more or less problematical new departures.

Instruction in Various Districts

In the Manchester district, in addition to excellent evening science and technological classes, a special all-day class is held on Mondays and is attended by selected apprentices of a certain standard of attainments, who are alternately paid for the time absent from work, or have the class fees paid by the employing firm. By this plan home lessons can be prepared on the remaining evenings of the week without involving the time-wasting and fatiguing journeys to and from school necessarily performed by evening students. The plan meets with tolerable success, its initiation being due to the action of the local educational authorities, who have tried hard to ascertain what employers, apprentices and parents really want—if they really *want* anything at all.

In the Bolton district a number of employers pay the night-class fees, in certain subjects, for their apprentices, and generally, act in conjunction with the educational bodies, some pains being taken to insure regular attendance during the winter. The general results are considered favorable. At Derby several concerns give a small increase of wages to apprentices who attend the classes well and display general diligence. This action had the immediate effect of largely increasing the number of students, the accommodation having to be enlarged, as parents, seeing a palpable cash benefit, exerted pressure on the boys. Probably greater general interest would be taken in the subject if the financial gain were more directly apparent.

Problems of the Future

A number of influential men—few of whom, however, are directly engaged in industrial administration—are urging on British employers and public the urgent advisability of apprenticeship to everyday manual crafts, with a view to a diminution in the amount of casual "unskilled" labor.

A few employers now appear inclined to inquire whether the percentage of unemployment caused by the introduction of improved machinery does not increase at such a ratio in advance of increased demand for products caused by the cheapening of production costs and selling prices, as to constitute a menace to the general well being. As one employer remarked, it is not much use making bigger profits on a larger turnover if unduly increased poor-law taxes are the result. As has been remarked editorially in this journal, increased production, no matter how obtained, appears in the long run to result in all sorts and conditions of men working harder for the same money as before or its equivalent, and the Twentieth century will have to answer many questions it raises.

Machine-tool Business

In the machine-tool manufacturing and selling industry no decidedly outstanding feature is noticeable, though certain general tendencies have gained ground during the year. One is the increasingly cosmopolitan and comprehensive lines on which the principal machine-tool and accessories dealers run their business. Formerly, high-class American, and medium British tools were chiefly dealt in. Now, German tools have in many instances proved excellent lines to handle, and the number of British machines, and their types, marketed by agents shows a decided increase. Tools formerly almost wholly of American origin, as universal grinders, special turret lathes, light and medium drill presses, etc., are now regularly built to stock by British builders and their output more or less fully disposed of through merchant channels. Again, the dealers themselves show an increasing disposition to manufacture tools on their own account as there is now little mystery allowed to attach to the production of accurate work and specialists in almost any line can easily be engaged. Consequently in certain cases it may be easier for an established firm of merchants to commence manufacture than for a manufacturing concern to establish a satisfactory merchant department.

One definite result of the developments of the last few years would appear to be the spread of the critical faculty among British tool users, so that neither British, American nor Continental tools now have the benefit of any special glamor to assist their sales. Consequently all builders—and perhaps in particular American builders—will need to concentrate a considerable amount of consideration on the selling end of their enterprises if they desire to reap the full benefit of the next trade revival, which it may be hoped will be of a more even and prolonged character than the last. At the time of writing there appears a fairly prevalent feeling that rock bottom has been touched and that the next movement will be, if but very slowly, in the upward direction.

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Widening a 6x4x15-foot Niles Planer

We had a 6x4x15-foot Niles planer, the largest in the shop, and on it were planed some air-compressor beds. This planer was bought some four years previous to meet the existing conditions and allow a liberal margin for expansion of castings to be planed as the size of the machines increased. But the day came, as it does with many manufacturers, that the castings outgrew the planer. One day we had a duplex air-compressor base 98 inches wide. This base has finish on two sides, the top and the bottom.

An open-side planer was out of the question as the top and both sides were to be planed simultaneously.

The next idea was to buy a larger planer with the promise of delivery one year off and a compressor due in three months. This also was out of the question. There was one thing left—to widen the planer, and this we decided to do. The cutting speed of the table was 20 feet, as was also the return. It was also decided to add a change-speed box which would give four cutting speeds, of 20, 25, 30 and 35 feet, with a constant return of 35 feet.

The planer, in Fig. 1, as it is now, can be speeded to suit the job. It has been running three years and is a success.

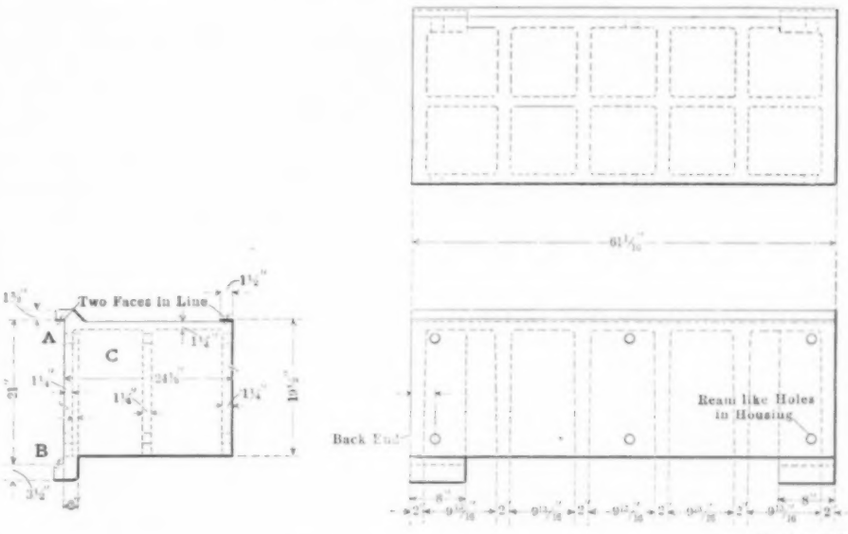


FIG. 2. THE DISTANCE PIECE

Fig. 2 shows in detail the piece put between the bed and housing to widen the planer. At the top a new arch was required and also a new rail. The lug at *A* is to take the weight of the housing. Between the two lugs *B* and the bed wedges were driven to take the shear off the six bolts which hold the housing to the bed. The six bolts were a good fit in the distance piece *C* and the housing. They were transferred from the housing to a plate, which was in turn used for a jig for the distance piece.

Claremont, N. H. J. C. DUFRESNE.

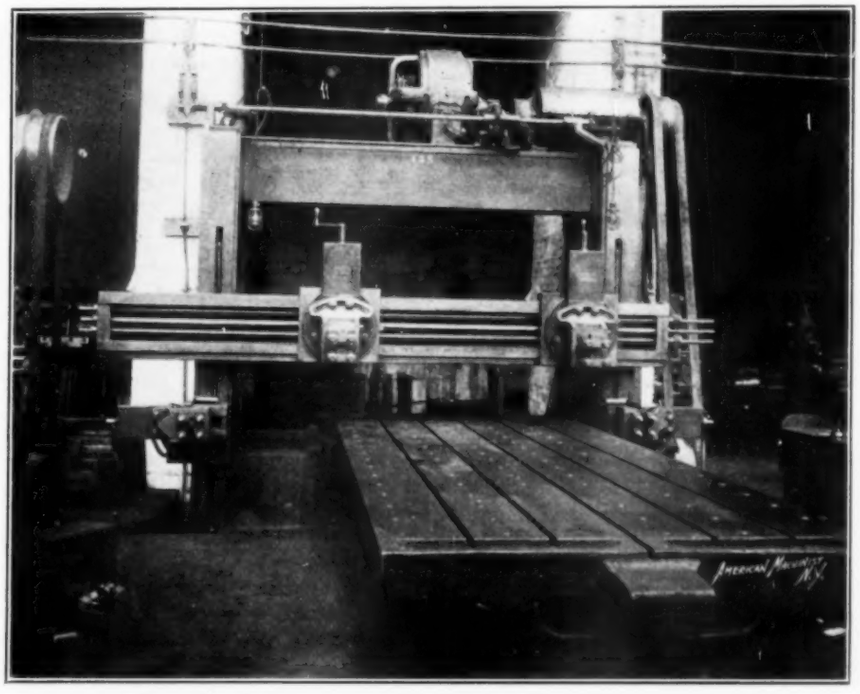


FIG. 1. THE WIDENED PLANER

An Information Form for Special Orders

Possibly the following brief description of a special form, recently adopted by one of the leading manufacturers of machine-tool specialties in New England, will be of interest to managers and engineers having in charge quotations, etc.

Furnished on this Order:

Special Patterns.	Special Material.	Price	Cost	Memorandum
				See drawing 76-File 15

American Machinist, N.Y.

AN INFORMATION FORM FOR SPECIAL ORDERS

Frequently orders are received for a tool with special features to adapt it more thoroughly to the requirements of the purchaser. Such changes from the standard sometimes require considerable correspondence, resulting in the accumulation of many letters (all the letters be-

ing kept together, with carbons of the outgoing letters attached). To avoid the necessity of reading through the entire collection of correspondence, the form shown in the cut was devised, and has proved helpful and a time-saver.

This form is carefully filled out after the shipment is made, and attached to the papers (on top) so that when a duplicate order is placed the whole matter is summarized fully on this sheet.

L. G. RUSSELL.

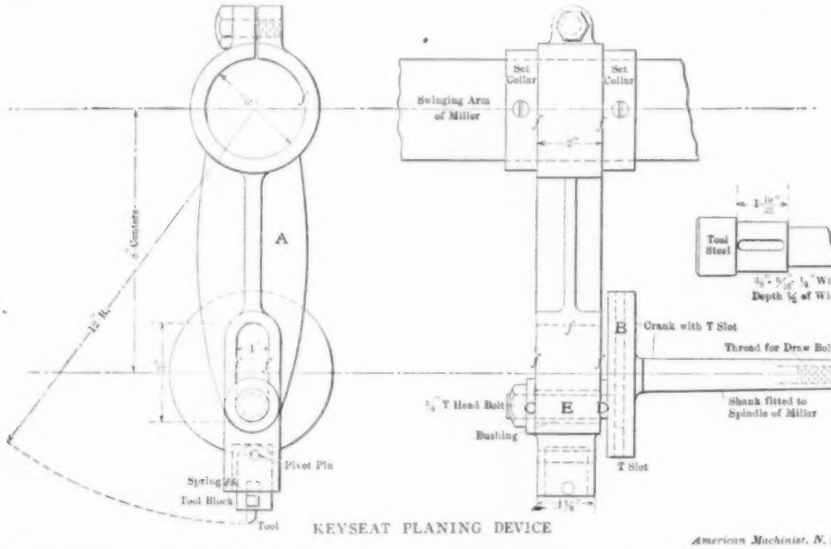
New London, Conn.

A Novel Keyseat Cutter

This shows a milling-machine attachment which may be of interest. It was designed for machining short, narrow keyseats, in which side and end fit only were to be considered.

This attachment consists of casting *A*, bored at upper end to fit arm on miller. It is split and provided with clamp screw to compensate for wear. The lower end is fitted with a tool block pivoted at top to allow for drag for return stroke. This casting *A*, is slotted at a point corresponding with center of miller. This slot receives a bushing on crank pin *E* which is clamped to face of crank *B*. This has shank fitting spindle of miller and gives a swinging motion to the casting *B*, virtually transforming the miller into a shaper.

I am now tooling out keyseats ¼x1 inch in 4 minutes each with this device.



KEYSEAT PLANING DEVICE

American Machinist, N. Y.

The keyseats are first drilled at each end, the work is held in a vise, and feed obtained by raising the table. The stroke of the machine can be adjusted from zero to a maximum of 2½ inches as laid out. Of course, there is a curve at bottom of keyseat. But as the final fit is pressed on, side and end fit only are necessary. The radius at 12 inches gives about 0.001 per inch curve at bottom.

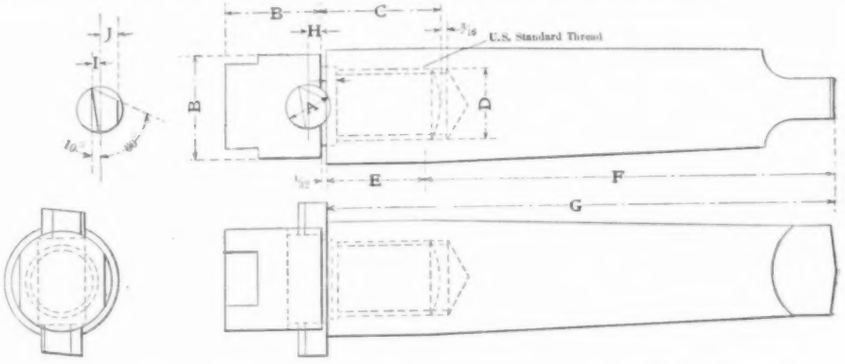
This device has helped me out of a bad hole, and I think it is new. It beats any end mill scheme I have ever seen.

Jersey City, N. J. J. W. THAYER.

Counterbores with Round Steel Cutters

The drawing shows a counterbore which I have designed. I have made three of each size and they have proved to be good, clean-cutting tools. The table gives the dimensions for the different sizes of counterbores. The shanks are made of machine steel with the edge where the cutter bears case-hardened with cyanide of potassium. The tits are made of machine steel also and case-hardened all over. The cutters are standard drill rod and by using this the expense of turning the cutters is avoided. The advantage of this tool is in the saving of tool steel. If the cutter is broken there is not much loss.

Plainfield, N. J. JOSEPH WEANER.



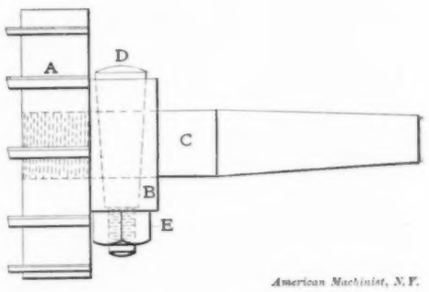
Morse Taper Shank	Counter Bore A	B	C	Drill D	Tap	E	F	G	H	I	J	
1	5/16	5/16 to 3/8	3/16	1/4	5/16	1	2 9/16	3 5/16	1/32	1/64	5/16	
2	1/4	3/8 to 5/8	5/8	11/32	7/16	1 3/8	3 5/16	4 3/16	3/64	1/16	5/64	
3	3/8	5/8 to 7/8	15/16	23/64	5/8	1 3/4	3 3/4	5 1/8	1/32	1/32	1/8	
4	1/2	7/8 to 1 3/8	1 1/4	3/4	7/8	2	4 3/4	6 3/4	1/8	1/8	1/32	
5	5/8	1 3/8 to 2	1 5/8	1 3/4	1 1/4	2 1/2	6	8 3/8	1/16	1/32	1/32	

American Machinist, N. Y.

COUNTERBORE AND TABLE OF DIMENSIONS

A Milling Machine Arbor for Facing Cutters

The sketch shows a milling-machine arbor designed to facilitate the removal of facing cutters. With the ordinary arbor great difficulty is often experienced in getting the cutter off, especially when it has been on the arbor for some time. It is customary to remove the cutter by placing a piece of brass against the edge of a tooth as at *A* and knocking it off with a hammer. This often results in damaging the cutter or knocking it out of truth; sometimes I have known the arbor itself to be knocked out of truth in this way. With the arbor shown, when putting the cutter on, first put on the collar *B*, which is made a good fit on the arbor body *C*, then put in the taper pin *D* and screw up tight with nut *E*. Now put the cutter on in the ordinary way by screwing it up to the collar *B*. To take the cutter off unscrew nut *E* and knock out the taper pin with a lead hammer. The collar will then slide away from the cutter and the latter can be unscrewed by hand.



American Machinist, N. Y.

A FACING CUTTER ARBOR

Leicester, England. A. TIMMS.

Why a Compound Die Failed to Work

Until within the last few years a large number of the tin-can factories did not use the blanks that came from the fruit openings, or formed them by a separate operation into roofing caps. I have seen barrels upon barrels of these blanks (1¼ to 2½ inches diameter) ready to be sold as scrap, or to some novelty or tag factory, the price of roofing caps being so low as hardly to justify a boy's time and the power to form them up, except in the case of the largest sizes, which were cut into fruit-can caps for a smaller opening.

Some five years ago I suggested making a compound die for forming the fruit opening blank into a roofing cap at the same stroke of the press at which the can top was formed. At the time it was not thought practicable, but about a year ago I received a letter from a concern stating they had tried such a die but it did not work well; the roofing cap would "crimp" in spite of all they could do. Fig. 1 is a rough sketch of the lower half of this die as they made it, and Fig. 2 shows the form of the can top and the roofing cap made from material removed from the center of the can top. While of a fairly good construction, the die failed where the cap-drawing-ring spring was expected to take up. As can be seen in Fig. 1, a small plate *A* was fastened to the lower side of the movable plate of the main drawing-ring springs, and as these were compressed first, there was nothing for the pins and drawing ring of the cap to do but fall after the plate. If any pressure at all were ever brought to bear on the cap it was only at the end of the stroke due to the difference of tension of the two sets of springs.

Fig. 3 is a sectional construction drawing of the die as I then designed it for them. The general construction is changed slightly to help machine work, but the cap drawing-ring spring brings up on the same plate as the springs for the main drawing ring. This construction leaves a chance for individual regulation of tension on the two sets of springs. The pressure of the cap drawing-ring spring is increased or decreased by putting in or removing common washers *B* from under the movable plate. As a result of this change smooth caps are produced.

The air pipe acts as an auxiliary knock-out for the cap. From time to time a cap would be slow in sliding off or catch on the main drawing ring, spoiling all three pieces at the next stroke of the press. A very slight pressure of air lifts the caps clear of the die, and the press being on an incline, the caps fall clear.

Referring to the punch, it will be seen that the body *C* is made from machine steel with tool-steel cutting rings pressed on. This has no advantage except in the up-keep; in fact, the first cost would be greater than if made entirely of tool steel. As the cutting edges wear away the form is turned deeper, and with some four or five redressings the entire punch would have to be thrown away if made of solid tool steel, but in the construction shown the old form can be taken out, the cutting edge pressed off and others replaced at half the cost of a new punch. The knock-out ring is very heavy in order to allow a recess for the springs to enter instead of going up into the punch body. This construction gives a good working bearing for the springs as well as a long knock-out spring and still keeps the hight of the punch at a minimum, the type of press used for this work being very short from bolster to ram and requiring thin dies. A positive knockout is provided for the caps sometimes stick on the nail-hole punch.

Hartford, Conn. H. TERHUNE.

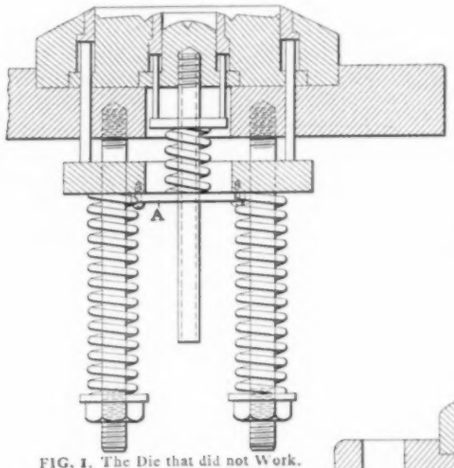


FIG. 1. The Die that did not Work.

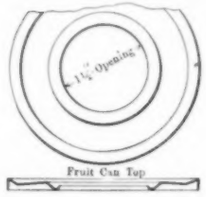


FIG. 2. The Work.

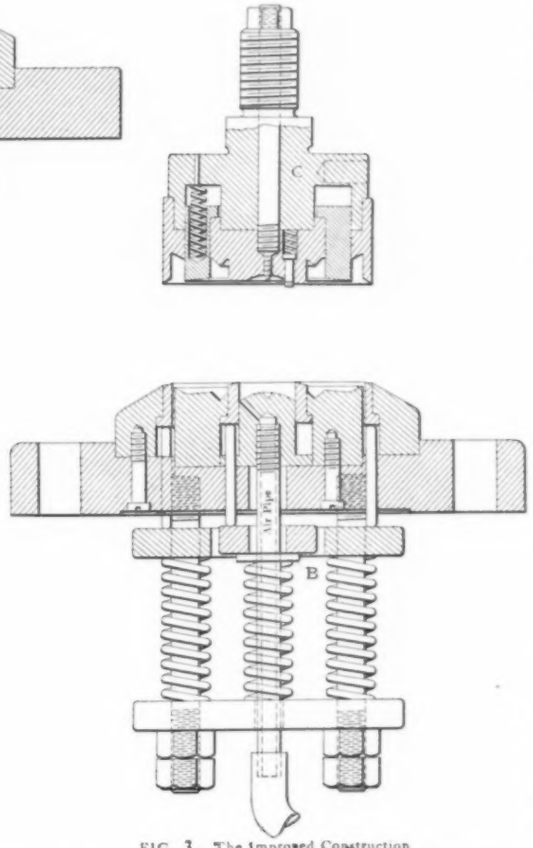


FIG. 3. The Improved Construction

American Machinist, N.Y.

COMPOUND DIES FOR CAN TOPS AND ROOFING CAPS

Grinding Hardened Rollers

Some 3000 7/16-inch rollers like Fig. 1 were turned in pairs, hardened, ground in pairs as in Fig. 1 and then broken apart so that the ends of each could be ground to 7/16 radius. Shortly after, a batch of 800 were made of nickel steel and cut off to required lengths, but after they were hardended they were too large in diameter, measuring 0.377 and 0.3765 inch, and this meant either opening out the holes in the articles which they were to fit or reducing the rolls, unless a new lot was made. The sketch, Fig. 2, shows how we overcame the difficulty. By inserting the roller in the groove in the end of the holder it was retained in place by the two flat springs pressing against the convex ends, and could then be held against a buff wheel coated with fine emery. The wheel was used on an ordinary polishing jack and while rotating the roller in the spring holder, reduced its diameter the 0.0015 inch necessary to bring it to the standard size.

We found that the rollers were all reduced very accurately, and only about one minute each was required to do the work.

A. S.

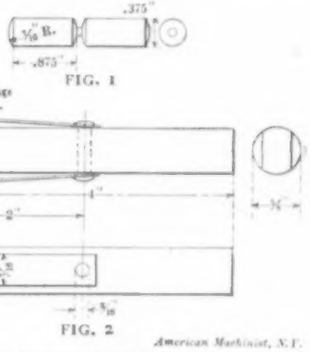


FIG. 2

American Machinist, N.Y.

HOLDER FOR GRINDING HARDENED ROLLERS

Semi-Automatic Trimming Die

The sketches illustrate a trimming die that I recently designed and built for trimming the friction and cut-out nozzle shown in Fig. 1. This is made of tagger's tin, and soldered in the opening of syrup cans making a safe seal for shipping and handling; it is intended that the consumer should cut out the head of the nozzle with a knife or can opener, the head being sunk down for this purpose, and the metal being only 6 or 7 thousandths thick makes this easily accomplished. A well fitting cover is placed over the nozzle before shipping which has the words "Pry this Up" embossed on it, and this serves to seal the can during the period the contents are being consumed. The opening in the can head is beveled to the same angle as that of the nozzle flange which then requires a minimum of solder for attaching. I mention these various features particularly as oftentimes a certain little detail means just as much money as the tools can save in the various operations. The production required was about 25,000 per day, and these tools will actually trim about 40,000 per day of 10 hours, at a labor cost of 5 cents per thousand, piece work.

In Fig. 1 *A* is a die plate of cast iron, *B* is the cutting-edge ring having but little clearance, say, about ½ degree, so as to hold the size within close limits, and the cutting edge is ground with three high and low places to make cutting easier, this distorting the scrap only. The work is to be trimmed bottom side up, as in this position the shape of the cutting punch *C*, whether flat or beveled inward or outward at the cutting edge will not affect or distort the work, and this leads to long life as the punch can be upset in the press room many times, provided the hammer marks are not too rough or uneven. Trimming the work right side up would make the punch very expensive to maintain and would distort the work if the punch was upset only slightly. The punch is made of either unannealed or toughened steel, and when worn too short is cut back, a ring shrunk on and a cast-iron plug driven inside to furnish renewed backing for *D*. *D* is a pick-up plug held in place by the hollow bolt, and is designed both to center and pick-up work; *E* is a knock-out which forces the work off after the punch rises high enough to clear the die. Ring *F* is an ejector operated by the springs shown which must be strong enough to force the work out of die *B*. This is necessary as the pull of the pick-up *D*, considering the shape and lightness of the stock, would make the work hug the cutting-edge walls in *B* more tightly instead of picking it up easily. *G* is a pocket which catches the nozzles as they come from the device, and has half of the upper part cut away for that purpose. This can be seen better in the top and side views in Fig. 2. It is supported by a light spring and prevented from turning by a sliding pin. As seen in Fig. 1, considerable space is allowed below *F* and *G* for the usual accommodation of dust, grease and stripped-tin dust, a considerable quantity of which accumulates when the die remains in the press a month or so at a time. *H H* are scrap cutters which cut the trimmings after they have been forced up the body of the punch by their gradual accumulation until there is one too many between the edge of the cutters and the face of the cutting edge *B*, which by the way, should be flat rather than beveled at the very cutting edge to make it sharper, as this tends to spread the trimming to a slightly larger diameter, a difference sufficient to permit it to drop off the punch and into the die where it would give considerable trouble. If the cutters are long enough so that the trimmings do not bind in the fillet of the punch, the halves of the trimming will be thrown out on each side of the press where they can be caught in boxes.

Referring to Fig. 2, *I* is the chute or slide of U-section, as shown, and about 18 inches long, containing a number of nozzles which are retained by the upper bar *J*. *K* is the feed device operated by a finger projecting from the press ram and touching the lever *L*; this depresses the left end of *K* which carries a spring pin that holds the nozzle directly beneath it while the right end of *K*, bearing a solid pin, is lifted, allowing the nozzle between the pins to escape to *G*, the press being

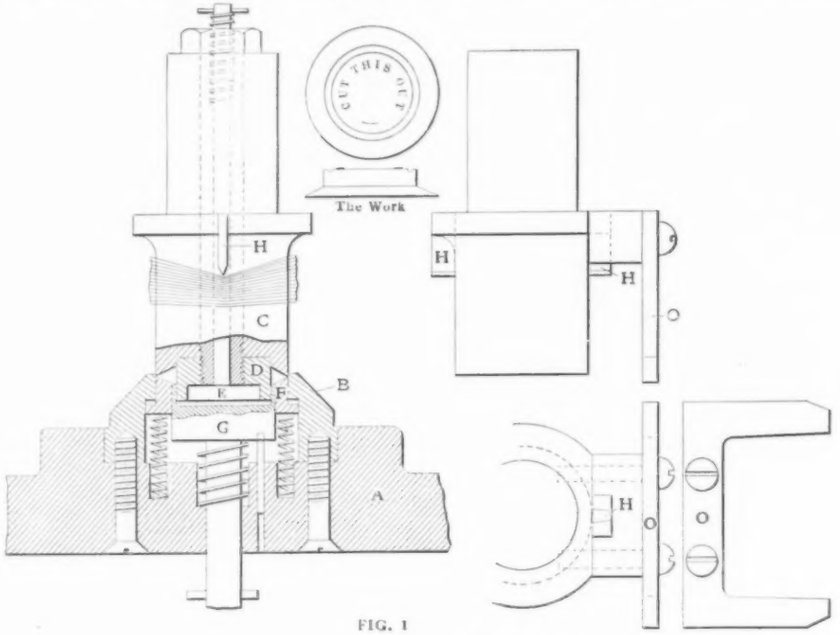


FIG. 1

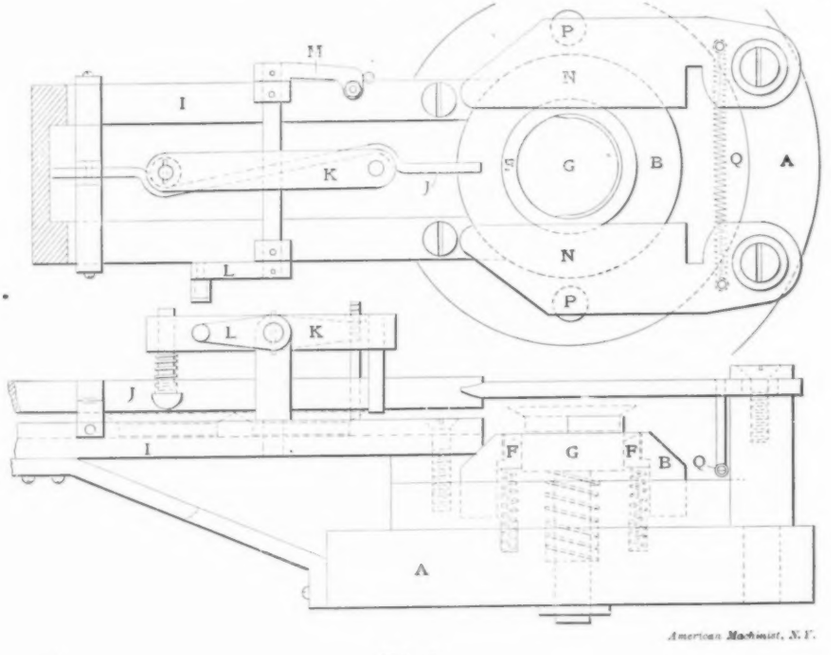


FIG. 2.
SEMI-AUTOMATIC TRIMMING DIE

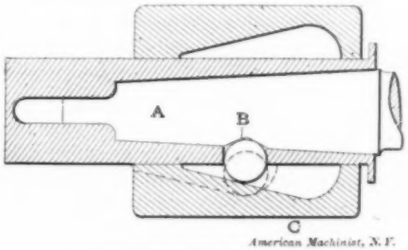
inclined. On the return of the ram to the upper position the coil spring on lever *M* carries the feeder back to the position determined by the stop pin also carried by the lever *M*. The spring pin on *K* then releases the row of nozzles in the chute *I*, which drop down to the solid pin on *K*, and the feed device is then ready for the next cycle. The two wings *N* perform a double function: first, they prevent the nozzle being fed from bouncing out or tipping out of the pocket *G*, and second, prevent the nozzle that is knocked off of *F* from striking the one in the pocket *G* and knocking it out also. These wings are operated by the dog *O*, Fig. 1, which is cut out to allow free passage of the nozzles as the punch shortens by wear and also so as not to interfere with falling nozzles. The wings *N* have additional supports at *P*, and these posts also act as stops for the wings. The wings are closed to these stops by the action of a coiled spring *G* put as far out of the way as possible.

This style of feed works very well on low work from ¾ to 6 inches in diameter, and adaptations of it are useful even on redrawing, burring, curling and end-punching dies if the work is not too high compared with its diameter. The speed at which it can be run varies from 20 to 200 per minute, depending on the operator's feeding ability, tendency of the work to nest up, the time required for the work to drop from feeder to die and the time required for the finished work to get out of the way of the descending punch. The tripping latches are arranged to permit the press to run continuously as long as the pedal is depressed.

Chicago, Ill. SIRIUS.

Special Drill Socket

The accompanying sketch may be of some interest if not of practical use to your readers. It shows a device for remedying the drill tang trouble. *A* is the drill shank which at *B* has a recess made with a drill point about 1/16 inch



SPECIAL DRILL SOCKET

deep. A steel ball is held in this recess in the drill shanks through a corresponding hole in the socket and pressed there by the sleeve *C*. This sleeve is made a sliding fit on the socket and can be lifted allowing the ball to fall back when the drill is to be removed.

This arrangement insures extra drive and safeguards the drill tangs while affording an efficient drive for tangless ones. The cost of high-speed steel drills makes this arrangement valuable where heavy and rapid work is being done.

Leeds, England. R. DILL.

A Catch in a Universal Coupling

There is an old story of a county fair; one of the attractions was a tent where a quarter was charged for admission to see a "horse with his head where his tail ought to be." Visitors were only admitted one at a time, and as each came out he was asked before the gaping crowd (such crowds always do gape, so why not say so?), whether or not he had seen a horse with his head where his tail ought to be. He always answered "yes," and if anyone volunteered more information he was promptly hustled out of range. Finally one farmer came out and answered, "Yes, by gosh, they just *backed* him into the stall," which gave away the plot.

Now I want to play farmer to a gaping crowd on the subject of universal couplings of the type shown in the cut, Fig. 1. This style of coupling is shown in prac-

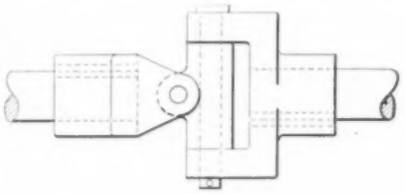


FIG. 1

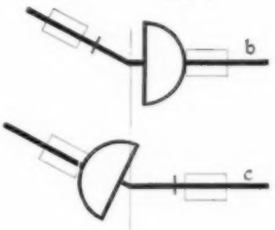


FIG. 2

American Machinist, N.Y.

A FAMILIAR UNIVERSAL COUPLING

tically every book on machine design that comes from England, and in a few that are published in America. None of these books intimates that there is any catch about it except Reauleaux, who mentions that there is a negligible error in the velocity transmitted due to the in-and-out motion of the couplings.

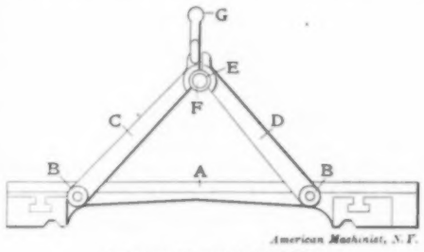
Reference to Fig. 2, *b* and *c* will show that unless the shafts are of rubber and the boxes float flexibly there will have to be an endwise sliding motion equal to double the distance between the centers of the cross pins. This sliding is accomplished by forces so nearly perpendicular to the shafts on which the sliding occurs that unless it is well lubricated there is a possibility that the thing will not go at all. There is also necessary a small amount of looseness in the boxes due to a tendency to lift at intermediate positions.

As Reauleaux intimates it is mainly suitable for farm machinery which is what leads me to tell the horse story.

Springfield, Mass. ENTROPY.

A Special Steady Rest

In our plant the machine work on large valves, etc., is done with cutter-head tools in a large turret lathe. The cutter-head bars are necessarily long, the vibration causing us to use a very small feed, and even then the results are not always what is desired. We needed a steady rest for the cutter head, but an ordinary rest could



A SPECIAL STEADY REST

not be used because of the size of the cutter head and our inability to back it out of the rest.

The steady rest shown was designed for this work and the results were all that could be desired. The device is so simple that the cut will explain itself. *A* is the lathe carriage, *B* are pins tapped into the carriage and on which the rest arms are free to turn. *C* is the rear arm, *D* is the front one, *E* is a brass bushing in which cutter-head bar slides freely. *F* is the cutter-head bar and *G* is a locking lever, split so as to slide over the lug on *D* and hold the whole device firmly.

When not in use the rear arm *C* rests on the rear part of the carriage *A* and is out of the way. The front arm *D* extends forward on the carriage in the same manner, or may be dropped under the spindle and rest on the rear of the carriage. The bushing is left on the cutter-head bar. In operation the cutter head is revolved into position by the turret. The front arm swung up against the bushing, the rear arm brought up, and the handle *G* pulled down locking the arms. We then have a good rigid bar which is readily fed forward into the work.

The rest is just as firm as a solid one and is operated in just about the same time. There are two pieces to be thrown into position instead of one, but the pieces are light as compared to a solid rest. When not in use the rest may be removed by taking off the nuts on the pins *B*. The whole attachment was fitted on at a very small cost.

Milwaukee, Wis. JOHN BAILEY.

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

A Combination Die for Shells

A. Whitby, on page 110, is quite right in stating that this method is in general practice in tinplate and thin sheet-metal work. The welding of cast-steel working parts upon mild-steel plates and shanks, is far superior to securing with screws, owing to the great strain placed upon this class of tool by the operators not seeing that all shells are ejected properly, allowing some to accumulate in die, before stopping it, or it stops itself, even good welds are sometimes pulled off in this manner.

Though A. Whitby's cut shows clearly, I cannot see any provision made for stripping the scrap from the blanking punch, which will have the scrap fixed at any hight, according to the depth of draw. A simple method to release the scrap is shown in the accompanying cuts of a combination tool for sardine boxes, and consists of a knife, fixed on the blanking punch, engaging with the edge of the die, sufficient to cut stock through.

Fig. 2 shows the body. Fig. 1 shows the tools partly in section, in which *A* is a tool-steel die welded to a machine-steel plate. *B* is the tool-steel punch. *C* is the machine-steel pressure ring. *D* is the machine-steel bolster plate. *E* are tool-steel pins. *F* are machine-steel buffer plates. *G* is tool-steel punch welded to machine-steel shank. *H* tool-steel extractor pad. *I* machine-steel adjusting packing. *J* spring. *K* tool-steel scrap cutter.

The method of manufacture is as follows, and is general for all square or irregular shapes.

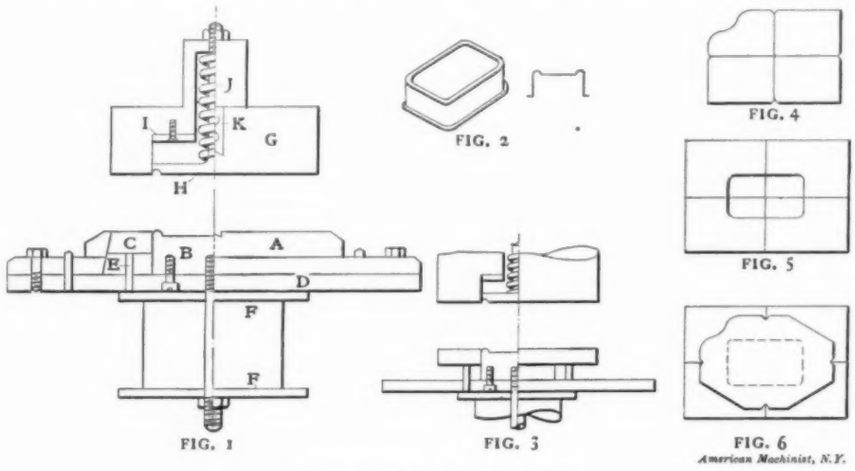
The drawing punch is machined and finished to the required size for the inside of the body, the drawing die being faced and recessed to the size of the punch, plus twice the thickness of the stock. It is very important that the drawing faces should be quite smooth. The pressure pin holes are drilled and pins cut equal length, from bright cast-steel stock, are fitted and burred slightly to prevent them falling through. The incomplete tool is now assembled with pressure rubber fixed and placed in the press to try the draw, see Fig. 3.

There are several things to prevent free draw at first trial; the die may require easing, especially at the corners, the drawing radius may be too small, and the working pressure of the rubber has to be found. After adjustment of the tools, until it takes printed stock without scratching or wrinkling, the finding of the blank is proceeded with, this in square or irregular shaped work can only be found by trial. A sheet-iron templet is cut and lines scribed through the center and notched on the edges (see Fig. 4), similar lines are scribed on the punch and pressure ring, Fig. 5. These lines are used to set the trial blanks, which are notched the same as the templet, and make the placing into position very easy, see Fig. 6. One corner of templet only is roughly cut to shape, see Fig. 4, and this corner is worked upon until the shape and depth are correct, the other three corners of the trial blanks are cut right away. One corner being found, the other corners of the blank are made similar and we have the templet with which to mark out and machine the blanking die.

The die is machined at an angle of clearance small enough to allow fitting the templet to within a tenth of an inch of the top, as in hardening they generally open a little. The shearing and cutting edge for the stripper knife are filed and the die hardened.

The pressure ring and blanking punch are lined off from the die and machined. The pressure ring with the same taper as the die, and the punch with a small taper to facilitate the fitting of the punch up through the die. Great care should be taken to keep both the draw die and the hole in the pressure ring concentric with the cutting edges of the punch and the edge of the ring. The punch is left soft to throw all the wear upon it, and when in want of repair, is peened on the face and sheared into the die when in position in the press, the face being then leveled and scraped up again, and enough being taken off the packing piece to allow the proper depth of draw. The bottom tool is assembled, drilled, and tapped for pins and screws, the pressure ring being jammed up tight enough to keep the parts in place. The tools are now placed in the press for trial and fitting of the scrap cutter, which, when fixed into position, should be a shear edge with die but never bottom, the scrap being split, is easily removed.

London, Egland. NOVUS HOMO.



A COMBINATION DIE FOR SHELLS

Down with the Standard Involute Gear Tooth!

I read with great satisfaction that some of the learned men of gearing propose to unstandardize the involute gear-tooth system by changing its present really standard angle of action to some other angle, so as to allow of a pinion of 12 teeth in the interchangeable set without rubbing off the corners that are bound to get rubbed off anyway.

I am heartily in favor of changing the angle of action, of changing anything and everything else about the tooth, and changing it as often as possible. The Brown & Sharpe standard has about run all the other propositions out, and, with its various copies that go by other names, is pretty much the whole thing. It is taught in all the schools and practiced in all the shops, so that when you say *gear tooth* you mean that and nothing else. This condition of affairs is quite scandalous; the public is getting so that it knows altogether too much about the matter, and that is bad for business. We specialists

have got to stop cutting each other's throats long enough to knock out this standard and get the public hopelessly muddled, bewildered and exasperated, so that it will not be able to tell a gear wheel from a cart wheel and will have to take whatever we see fit to hand out. We can then attend to each other as usual.

I have been doing my best for many years, by writing to the AMERICAN MACHINIST and by publishing a "Treatise of Geartoothology," to get my customers tangled in a mesh of epicycloids and "sich," but it never occurred to me that a change in the form of the tooth would serve the purpose better. The A. S. M. E. gear cranks are smarter than I am and I cheerfully admit that their scheme is better and wilier than mine. Success to the movement! Down with the gear tooth standard! Down with everything else that gets too fixed and simple and spoils our graft by allowing any sort of a mutt to cut his own gears!

When the A. S. M. E. combine has gotten the standard well mixed up and changed about—what else is the A. S. M. E. good for, anyway?—I am going out with my new *sinusoidalistic* gear tooth, and change it some more. Brown & Sharpe Company did as well as they could in the state of the art when they adopted the involute, and are not to be blamed because they had not heard of the sinusoid. It will make a commotion; and commotion makes business.

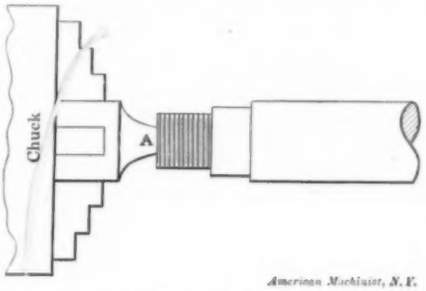
I observe that the U. S. Government proposes to adopt the metric system of measurements for all government work, whether it is done in the government or in private shops, including gearing and that will help us out a whole lot. Chemists and botanists and bug collectors have adopted this standard and, of course, the machinist must follow suit or remain in his present unscientific condition. The argument is irresistible; science is fashionable. The average machinist understands sixteenths and one-hundred-and-twenty-eighths but balks at tenths and hundredths of an inch, and if we can force the mysterious millimeter on him we will have him crowded out of the competition altogether. Next thing we know the government workman will be required to wax his mustache and talk through his nose.

The best part of the proposition is that the Brown & Sharpe standard is so fastened onto us that all the gear cranks in the country cannot knock it clear out. The new forms will be just so many more piled on top of the present ones, and the whole will go along together and merrily mix as they go. When we have 40 standards each one will have its advocates, and it will take a genuine Darwin to tell which species is the fittest to survive the struggle for existence. But I'll bet a hat on the Brown & Sharpe involute until the sinusoid is ready for business.

Philadelphia, Penn. GEORGE B. GRANT.

Cutting a Thread on an 8-inch Pipe

The article on page 187, on cutting a thread on an 8-inch pipe that was longer than the lathe and using two lathes to do the job recalls a shaft I turned some time ago. This shaft was about 6 feet longer than the lathe and was forged 1 foot longer than the finished length. I



CUTTING THE SHAFT

put a crab spider on the rough shaft and with one end in a 4-jawed chuck I turned the steady-rest spots. I then rough-turned the full length of the lathe, then turned the shaft end for end and rough-turned it. I then returned the steady-rest spots and was ready to finish-turn. After it was finish-turned and shoulder cut I cut the thread and turned the end, but left it thick enough at *A* to support the shaft; this was cut off with a hacksaw.

THOMAS A. WALLACE.

Germantown, Penn.

W. H. K.'s article on page 187 on threading long pipe in the lathe recalls to my mind the contrivance I used to cut 11½ threads on a number of pieces of 2½-inch pipe that were already cut to length and were perhaps twice as long as the lathe, the only machine available.

I chucked a piece of round steel, of suitable size, with about 4 inches projecting from the jaws, cut a 11½ ratchet thread, not too deeply inclined toward the chuck, and tapered about 1 inch per foot. Then I removed the tailstock, put up the steady-rest at the extreme end of the bed, adjusted its jaws to carry the pipe central, screwed the pipe end to be threaded on the "mandrel" and proceeded to cut the threads. On the job in question this rig was convenient, efficient, and altogether satisfactory.

Shreveport, La. M. S.

On page 187 W. H. K. describes a way of threading a long pipe which appears to me an unnecessarily long and expensive process. I often have large pipes 20 feet long to thread and my longest lathe admits only 8 feet. My method is to grip the pipe by the inside with a 4-jawed chuck and run it in the steady-rest placed at the extreme end of the bed, the tailstock being removed. Then I cut the thread on the end nearest the headstock. Having no taper attachment I produce the taper by feeding in the tool as it travels to the end, which is near enough for all practical purposes

However, I will remember W. H. K.'s arrangement as it will be useful for turning taper on the ends of long shafts.

Victoria, B. C. H. C. G.

Some Limitations of the Scleroscope

I am sure that there are few men who term themselves experts in the hardening and tempering of tool steel who do not sit up and take notice when they see an article from Mr. Shore's pen. But it is evident to me that Mr. Shore must go slow in his statements or he will get the users of the scleroscope all tangled up and in fact he will drive his tool from the shop entirely, or the tool hardener from his happy home to the unknown or lost list.

His article on page 222, No. 6, of the present volume of the AMERICAN MACHINIST, is surely very interesting reading, especially if you are a tool hardener and you are working under the observation of the scleroscope. As Mr. Shore has stated that he and his corps of experts are hardening steel and computing data for us tool hardeners, we at least ought to help him to see the light.

HARDNESS OF METAL TO BE CUT VERSUS HARDNESS OF CUTTING TOOL

His first statement that interested me was, "that in order to find what kind of a tool to use on any given steel to be machined was to multiply the degrees of hardness of the steel by 3 and this would give the degrees of hardness of the tool required to do the work." Now this is all right on some work or for some given conditions, but it is a positive rule, and must the tool cut and hold the edge as he says?

This rule will not and does not apply to alloyed steels when they are to be machined. In the shop where I work we have to machine just that kind of steel, and will my foreman come to, after reading Mr. Shore's article, and discharge me because my tools will not do as Mr. Shore says his will do, no matter how slow the speed and feed used?

THREAD-CUTTING DIES

We next consider Mr. Shore's method of treating taps, and thread-cutting dies; and just think of it, the ones that were brought into the test were some that were overheated until they were crystallized. Truly this is sad; but those days are going by, as we do not find much of this where real tool hardening is to be done, and the scleroscope is used. Is it any wonder that they were broken after being heated to a heat that would cause them to crystallize?

Now Mr. Shore would also have us infer that the proper temper for these par-

ticular threading dies was 85 hard or a blue, which is about 600 degrees, Fahrenheit. But steel such as is termed carbon steel, and can be bought in the open market, cannot be hardened and drawn to 600 degrees Fahrenheit and then used in dies for cutting a thread on even cold-rolled machinery steel. This is getting beyond where the steel is of any use for cutting. It means drawing the steel 50 degrees Fahrenheit more than the best temper for a cold chisel: It is even a higher drawing temperature than is required for a common wood saw: And it is also 140 degrees more than that to which threading dies are usually drawn.

Taps

He speaks of the tap being liable to greater strain, and for that reason he finds it best to draw the temper to prevent breaking only under certain conditions. This is not necessary on all taps and I will cite a test: First let us take a 3/16-inch tap and heat it to a few degrees above the recalescence point, then plunge it in water, and it will be found impossible to get it out of the water quickly enough to have it anything but hard on the cutting edges.

Next take a 5/8-inch tap and heat it to precisely the same heat, then quench it in water long enough to harden the cutting edges only, then remove it from the water and finish cooling it in oil and what have we? We have a tap that should and will stand to be 15 scleroscope degrees harder than the smaller one. This leads us to another question: Is there any mechanical way of applying a scleroscope to taps with hardened cutting edges and a soft center? I do not say these taps should not be drawn but they need not be drawn to prevent breakage.

Under the heading "Fallacy of the Temper Range," we find a considerable difference in the range of temper colors from those given by Mr. Shore. First we find a true blue to be 560 degrees Fahrenheit while Mr. Shore makes it 600 degrees, and there is but 5 degrees difference between his purple and ours. And yet we use his scleroscope.

Flexibility and Strength

Again Mr. Shore tells us that the higher-carbon steels are more flexible than steels of lower-carbon contents, but the most that these charted tests show is that on a bending test, a soft piece of steel is harder to break than a hard piece and will bend to a sharper angle before breaking. This cannot be claimed as a wonderful discovery, as it is known to every hardener who has hardened a lathe tool, and this tool has to stand strains similar to those given by Mr. Shore in his special machine.

We made some tests, along this line, during 1906, and found it was possible to give two pieces precisely the same heat, only under different conditions, with the following results:

The pieces used for the test were ¼x1½x2½ inches. We hardened a number of these by quenching them in a salt bath from a temperature of 1325 degrees Fahrenheit, then we drew the temper on one of each to 450 degrees Fahrenheit to 460 degrees Fahrenheit, and every 10 degrees thereafter until we reached 560 degrees Fahrenheit; then we applied the flexible test by placing two triangle bars 1½ inches apart, with another over the top. The machine was then run down to where the pieces broke.

The first two pieces were not drawn after hardening, and one piece broke at 1400 pounds, while the other broke at 4700 pounds. We were able to get 5400 pounds from one of the pair drawn to 560 degrees Fahrenheit, but with the other method of heating we were not able to increase the number of pounds to any extent. When Mr. Shore explains this I will begin to think that he has made a wonderful discovery, quite different from what he claims to have found.

High-speed Steel

In his tests of high-speed steel he has precisely what we have, in some instances, but he has entirely different results in cooling high-speed steel. He claims that the air-hardened pieces were stronger by 12 per cent. and the average strength was about the same as good carbon steel, drawn to a straw color.

We are able to get some high-speed steel harder than others by adding more air in the heating than is usually used. The scleroscope, however, will not show any difference for us on steel cooled in air, and steel cooled in oil, both having the same heat. Neither will it make any different showing if the steel is cooled in red-hot cyanide. In fact, the hardest pieces of high-speed steel (102 degrees hard) that we have tested with the scleroscope is steel that was cooled in a bath heated to 1292 degrees Fahrenheit, and when the steel had reached the heat of the bath it was removed and finished cooling in oil.

Tests of High-speed Steel

We took a number of pieces of high-speed steel, ground them to 5/16x1x6 inches, and broke them as stated above, and they broke at from 7000 to 7065 pounds pressure. Some of the pieces took a permanent set of 0.19 inch.

We then took a number of 5/16-inch square pieces, placed them on the triangular blocks, set 1½ inches apart, and we found that the ones that had the most air in the hardening heat broke under a strain of from 1910 to 2100 pounds. Other pieces hardened in the regular way broke under a strain of from 3900 to 4065 pounds.

We have become thoroughly convinced for some time that the degree of hardness of high-speed steel is entirely controlled by the heat given it in the hardening, and it is through the aid of the scleroscope that we have been able to fully determine this.

Other Points of Difference

There are many other points on which I would be obliged to differ with Mr. Shore. His statement that tool steel begins with steel of 90 per cent. carbon, does not fully meet with our experience, for we find that steel of 60 per cent. carbon will take a distinct temper, and we can see no reason for not classing it as tool steel.

We have a continued demand for steel under 90 per cent. carbon and we often use this scleroscope for testing tools made of from 65 to 75 per cent. carbon. Let us, therefore, use what we have and learn to use the scleroscope while we are doing so. We will then be able to know that the tool will do the work from the treatment that it has been given.

I am thoroughly convinced of the usefulness of the scleroscope, but I am sure we cannot look for it to establish laws to govern machining of all steels. Where the work cuts easily we do not need it so badly as where the work is tough and hard. We must, therefore, go slow or we will destroy the prestige of the only reliable hardness-testing tool that we have.

Davenport, Iowa. C. U. Scott.

Hobs with Inserted Teeth

I was much interested in Mr. Thompson's article, page 126, describing the patent hob made by Humpage, Thompson & Hardy, for which Mr. Thompson claims such accuracy, and also by the article (which, by a strange coincidence, appeared in the same number) from Entropy, entitled, "Accuracy, a Comparative Term."

If we apply Entropy's logic, which might also be called "horse sense," to hobs for generating involute teeth, we might say that *accurate involute* is also a comparative term. Mr. Thompson says that most motor-car manufacturers rough out their gears with a hob, and finish them with a cutter shaped to the correct number of teeth. Now this may be right, but I think the majority of them use standard cutters that have a certain range, therefore, are an approximation. At the same time, while claiming accuracy for hobbed work, Mr. Thompson admits that cutters which are an approximation to the correct involute give the best running result. Then why strain after the correct involute which, when produced, gives noisy running? The reason that gears which are cut with standard cutters run quieter, is, that they cut a clearance from the correct curve at the point of

entry and consequently we get a comparatively quiet approach.

Now, if we do as Mr. Thompson says we should not do, that is, get away from the fetish of the straight sides, we can have a hob that will clear away the tips of the teeth enough to insure smoothness and quietness in running. It would be interesting to know the comparative accuracy between a hob made by the process described and a solid hob made by a first-class maker, because there is much to be said for the hob described if its accuracy can be guaranteed. I must admit, however, that personally I have a prejudice against any blade being turned round in its place after grinding, probably because my experience in this respect has been unfortunate.

Now, if I understand rightly, this hob is not swiveled; this surely makes for poor results. If we take a hob 6 inches in diameter (an abnormal size) and ½ inch pitch, we should have about 3 degrees more clearance on one side of the teeth than the other. This would cause pushing, or that tendency.

Again, by having all the teeth in a straight line they all come into action together, causing a jump, especially when starting into the cut, while, with a hob grooved normal to the thread and swiveled round to the necessary angle, the teeth do not come into action together, but a fraction of time behind each other.

Before concluding I should like to say that my reason for this letter is not to criticize Mr. Thompson's excellent article, but to raise a discussion on the points mentioned.

WALTER G. GROOCOCK.

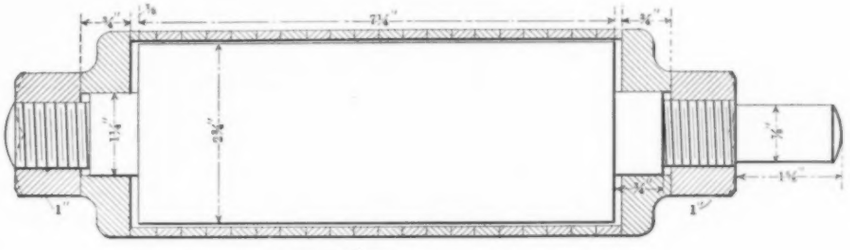
Woolwich, England.

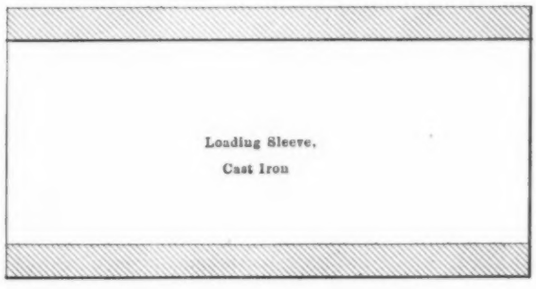
Piston Ring Grinding Fixture

Apropos the article by R. B. Lovejoy on above at page 73.

Apart from the inordinate time required to load this rig, surely we are not to believe that a *cast-iron* spindle, bored and threaded to fit the steel nose of the machine spindle, and to be removed frequently, will run true for any length of time; on a grinding machine, too, and probably surrounded by other grinders.

The principle is wrong from its start. By threading the spindle and thereby making it integral with the machine spindle, error is directly continued on to the work, since we must agree that a running fit is not a perfect fit. Assuming the error, as between the machine spindle and its bearings, to be negligible in itself, the fact must not be lost sight of, that the error will be multiplied by adding another spindle lengthwise.





American Machinist, N.Y.

PISTON-RING GRINDING FIXTURE

This important defect is further enhanced in the present instance by the added spindle being of such material as least to enable it to withstand the wear imposed upon it, even neglecting particles of emery deposited on the machine-spindle nose (while the fixture is not in use) from other machines in the vicinity.

As regards loading the rings, this operation should be performed by a boy (assuming the rings are done in quantities), and not necessitate any bolting or unbolting at all beyond the nut which clamps the rings laterally. In the rig referred to, it is necessary to spend some little time adjusting the cylinder to correct size, before it can be loaded; surely a plain cast-iron tube, without lugs, bolts, liners, or split, would be far easier to handle, and the first cost would be considerably less. The fact of two or three different sizes being accommodated with the split cylinder, is a doubtful advantage, since only one true circle can be obtained, and farther, loose liners would be a source of trouble from the time they were first made. Even admitting the fixture were such as to assure accuracy for a considerable time—which it does not—I venture to think it would not be adopted by those making rings in quantities, first, on the ground of initial cost (one complete rig only accommodating, say, three sizes of rings), and second, the abnormal time required to load, thus adding to the cost of the completed ring. During experience on this class of work, where several machines were constantly engaged, it was found that greatest expedition, coupled with accuracy, could be maintained by using a plain mandrel, nicely centered, and run on well-ground centers (a point often not receiving the attention its importance merits), threaded at either end, and having plain end plates, clamped by nuts, as shown in the line cut.

The cylinder, of cast iron, is bored and buffed to provide a surface on which rings will slide. The mandrel end plates are turned to fit each size of cylinder. To load, the rings are sprung into the cylinder, with their splits alternately right and left, and the mandrel is inserted with one nut and plate removed, these being then replaced and tightly clamped. A convenient mandrel press having a lead-loaded nose, was used to remove the mandrel from the cylinder, the lead nose preventing the mandrel center being injured.

With this rig the first cost is extremely low, as is also maintenance. One mandrel may be used for a large range of sizes. All plates have standard holes, and the nuts are interchangeable.

Provided all centers are kept in good condition, the mandrel properly adjusted on the centers, and the usual details attended to, accurate work should be readily obtained and maintained.

H. PEARMAN.

Basingstoke, England.

Osborne's Wonder Clock

D. A. Manson's solution, at page 277, of how Osborne's wonder clock was made to keep time is correct. I made the hour hand, as there was only one on this clock, more than 20 years ago for a jeweler on the corner of Spring and Court street, Los Angeles, Cal., and after setting the movement in place whittled and drove in small nails until it was balanced to suit. His store had a show window cut at a 45-degree angle with the sides and the line of this was about north and south. He told me it would not perform well unless set in this way. How much truth was in that I don't know.

Bridgeport, Conn. J. E. MERRILL.

The Newer British High-speed Steels

EDITORIAL CORRESPONDENCE

The small storm arising in Great Britain from unauthorized introduction having passed away, the newer high-speed steels have not been found to be such a menace to the machine-tool manufacturer as was at first thought likely. It was asserted that the newer steels would be of from 3 to 4 times the working capacity of the ordinary high-speed steel and the immediate supposition was that this referred to speeds.

It is on endurance under cut that the steels are now being pressed, rather than on any increase of cutting speed is, of course, an element for water-hardening.

Claims are made by some firms for a high-speed steel containing large quantities of tungsten. Another equally successful maker will liken a steel containing a large proportion of tungsten to a fighting man with exceptionally well developed muscles, and a weak chest. It appears, however, to be a fact that British steel makers can be officially informed of at least one of the special ingredients.

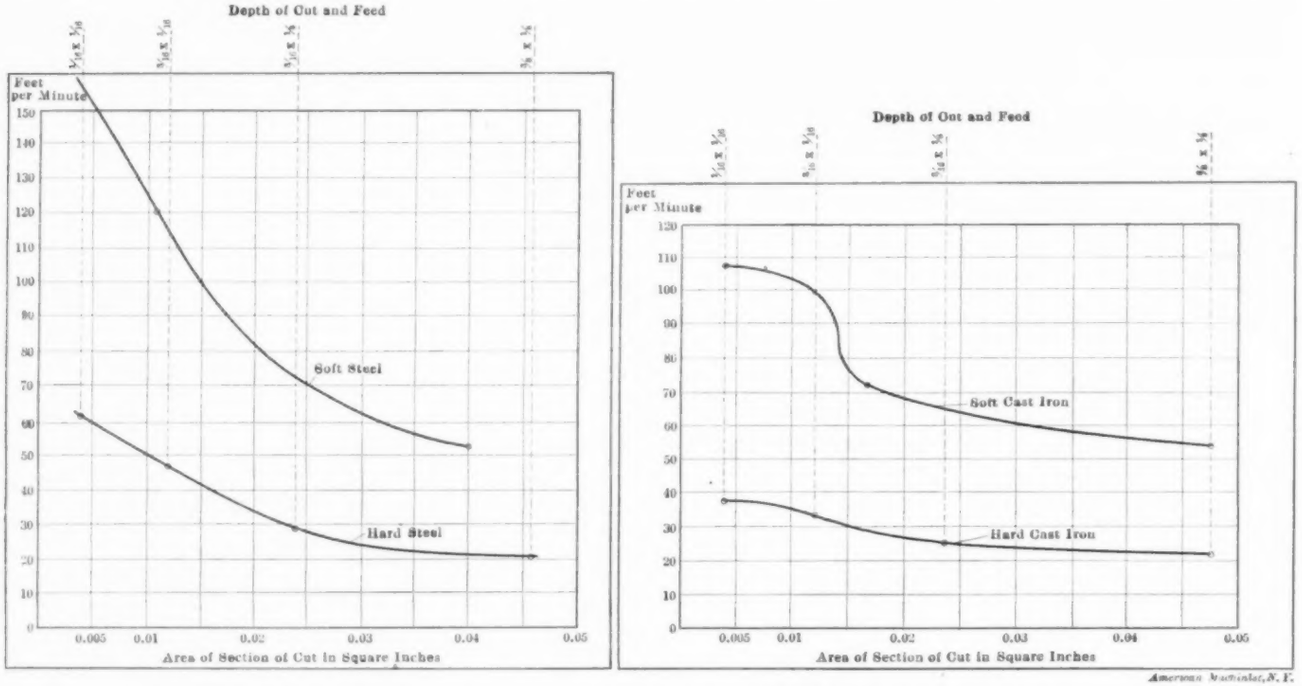
It will be remembered that Prof. J. O. Arnold, of Sheffield University, announced the coming of the newer steels as a kind of counterblast to derogatory statements made in America by Andrew Carnegie respecting British steel makers. The firm of Jonas & Colver immediately identified themselves with the newer steels and at least one interview was given to an ordinary daily newspaper, although other interviews have been repudiated. It was then felt by Sheffield steel makers that the local university was being used to the advantage of one particular firm, a feeling which, though quite natural, was without real foundation.

It is now stated that about 1899 Sir Joseph Jonas sent an expert who placed at the disposal of Professor Arnold quantities of a costly product which would, it was thought, greatly improve the qualities of steel. Professor Arnold experimented with this product, with results which were circulated among steel manufacturers. Jonas & Colver used the product mentioned in their newer high-speed steels. It has been officially announced that a copy of Professor Arnold's research can be seen by manufacturers on application to the registrar of Sheffield University.

The claims that were made at first for water-hardening can undoubtedly be sustained. All the same, there is a general tendency to drop this feature, and a firm, for instance, which has water-hardened a tool of its newer high-speed steel from 18 to 50 times, quenching directly in water without breaking or cracking the metal, will yet deprecate the process, holding that, at any rate for the present, air-hardening is right.

Directions given by Samuel Osborn & Co., Ltd., Sheffield, on hardening lathe and planer tools are that the cutting end should be reheated to a white welding heat (1250 degrees to 1300 degrees Centigrade) and immediately blown cold. But these directions are simply those issued for their ordinary high-speed steel. Most firms prefer to issue no special instructions, the idea being in some instances that the treatment is not yet standardized. Generally, however, it is thought that water-hardening is too severe on the steel. We know, for instance, of a case in which, when a firm introduced the newer steels, the first half dozen of the tools it supplied were cracked in the water treatment.

When, however, questions of endurance under cut arise, figures given quickly show the advantage of the newer steels. In the tables below I am giving data obtained from J. J. Saville & Co., Ltd., who have met with a more than ordinary success with newer steels. Then, too, Seebohm & Dieckstahl, Ltd., in an independent test away from their works, on an old lathe spindle, ran their Ultra Capital steel for 6¼ minutes against a tool of ordinary standard high-speed steel which lasted 20 seconds. The latter failed; the newer steel was only slightly worn. Here the


Depth of Cut and Feed
Feet per Minute
Soft Steel
Hard Steel
Area of Section of Cut in Square Inches
Depth of Cut and Feed
Feet per Minute
Soft Cast Iron
Hard Cast Iron
Area of Section of Cut in Square Inches

FIGS. 1 AND 2. CUTTING SPEED, FEEDS AND DEPTH OF CUT RECOMMENDED BY OSBORN & CO. LTD.

cutting speed was from 60 to 72½ feet per minute, the depth of cut being 5/32 inch with a 1/16-inch feed. The spindle was of very hard steel, kept, in fact, for test purposes.

This firm also tried an Ultra Capital high-speed steel tool 1½ inches square against an ordinary standard high-speed tool of precisely the same shape and section, both tools being hardened and prepared by the customer's own smith. They were used to turn a wrought-iron tail shaft, and while the newer steel was put in the front rest of the lathe, and was cutting on the scale throughout, the ordinary high-speed steel was placed in the back rest and was working on clean iron. It will be seen that the advantage of the conditions was certainly not with the newer steel tool. The speed varied slightly between 44 and 50 feet per minute. The feed was ⅛ inch, and the depth of cut for each tool ⅛ inch. With the two tools in operation the job was, therefore, reduced by ¼ inch in diameter. The ordinary high-speed tool traveled 11 inches, whereas the newer steel ran for 14 feet 6 inches before refusing to cut.

Osborn & Co., Ltd., turned nine locomotive steel tires without regrinding the tool against 1¾ tires, the average for ordinary high-speed steel. Their Mushet steels have recently been under trial in the Italian state railway shops, at Turin, turning old and new railway-wheel tires. The chief test, perhaps, was on a new shrunk-on tire said to be uneven in hardness, the steel being hard in spots. It was about 4 feet diameter and ran at a cutting speed of 8½ meters (about 26 feet) a minute, the highest available in the lathe. Here the cut, 12 millimeters deep and 6 millimeters traverse (about 0.47x0.235 inch), was taken right across the tire. When the cut broke through at the finish, the pressure being partly relieved, the traverse increased to about 10 millimeters (0.39 inch) for the last two revolutions, owing to the spring of the tool and machine. This was on the last of seven tests.

It may be of interest to give diagrams which show the area of cut and the cutting speeds recommended by this firm. Fig. 1 is for soft and hard steels, while Fig. 2 is for cast irons. These curves apply to the newer steel, but as a matter of fact were got out for ordinary Mushet high-speed turning tools. The humped character of the curve for soft cast iron shows that the cutting speed is not the same regular function of the area of cut as is the case, say, for mild steel.

Table 1 gives results of trials made at the Sheffield testing works of Thomas Nash & Sons, Ltd., the material cut being hard cast iron, analysis of which showed that it contained 1.06 per cent. combined carbon, 2.25 per cent. graphite and 1.02 per cent. silicon. The tools were used without lubrication and the depth of cut in each case was 3/16 inch (⅜ inch in diameter), the traverse being 1/16 inch per revolution, or 16 cuts to the inch. The endeavor was to keep the cutting speed at 60 feet per minute, this being measured at the bottom of the cut.

It will be seen that nine tools were tested, Nos. 1 and 2 being from a sample of the newest high-speed steels supplied by J. J. Saville & Co., Ltd., Sheffield, while Nos. 7 and 8 were from their ordinary brand high-speed steel. No. 9 similarly was ordinary high-speed steel by one of the best British makers, while tests Nos. 3, 4, 5 and 6 relate to a rival steel of the newer type. It is worth noting that No. 3, water-hardened, cracked longitudinally in the process. Names cannot, however, be given as the tests were not conducted with the authority of the makers; in addition, their tools were hardened by a professional expert hardener. Still, it would appear that some of the better brands of ordinary high-speed steel are about equal to some of the newer steels.

Tool.	How Hardened.	Duration of Cutting Time.	Actual Cutting Speed.	Actual Weight of Cuttings.	Condition of Tool.
		Min. Sec.	Ft. a Min.	Lb.	
(1) "Triumph Superb"	Water	11— 0	59.4	23	Worn.
(2) "Triumph Superb"	Air	8—42	60.8	19½	Worn.
(3) Newer high speed	Water	5—55	59.5	12½	Done up.
(4) Newer high speed	Air	0—37	60.0	1	Done up.
(5) Newer high speed	Air	0—28	60.0	½	Done up.
(6) Newer high speed	Water	2—30	59.6	½	Done up.
(7) "Triumph," ordinary	Water	3— 5	59.7	7	Done up.
(8) "Triumph," ordinary	Air	2—57	59.3	½	Done up.
(9) Ordinary high speed	Air	0—54	60.0	1½	Done up.

TABLE 1. CUTTING CAST IRON WITH THE NEW AND OLD HIGH-SPEED STEELS.

Table 2 gives similar figures relating to much the same tool steels. For instance, materials for tests Nos. 3 and 4 are the same as those for from Nos. 3 to 6 in the previous table, while again the last steels in the two tables are similar. Here, however, the material cut was forged steel, unannealed, containing 0.75 per cent. of carbon. The cutting speed was kept at about 50 feet per minute, the depth of cut was 3/16 inch, and the feed 16 cuts to the inch, as before, while once again no lubricant was used on the tool.

Here, again, the ordinary quality high-speed steel approaches in duration of cutting time to some of the newer steels. It may be worth while adding that an ordinary high-speed steel tool by Spear & Jackson, Ltd., when tested at the Sheffield Testing Works, Ltd., ran in the lathe for 4 minutes 51 seconds, removing 15.88 pounds of material, or 3.27 pounds per minute, with a cut of 3/16 inch and a feed of 1/16 inch at a cutting speed of 80.8 feet per minute before the tool failed. A roughing tool was, of course, used; when forged it was raised to a white heat and cooled in a cold-air blast. The material operated on was a steel bar containing 0.54 per cent. carbon, 0.098 per cent. silicon, 0.068 per cent. sulphur, 0.046 per cent. phosphorus and 0.82 per cent. manganese.

Few figures are available as to results obtained with the newer high-speed steels when used for twist drills. However, it has been stated that on a trial recently a 15/16-inch twist drill was run at 592 revolutions per minute. This corresponds to a peripheral speed of more than 140 feet per minute, and the feed was 20½ inches per minute. Against this we believe the previous best with ordinary high-speed steel was about 400 revolutions per minute and a feed of 12½ inches per minute. The drills were made by E. G. Wrigley & Co., Ltd., Birmingham, and the steel was Triumph Superior, mentioned above.

Tool.	How Hardened.	Duration of Cutting Time.	Actual Cutting Speed.	Actual Weight of Cuttings.	Condition of Tool.
		Min. Sec.	Ft. a Min.	Lb.	
(1) "Triumph Superb"	Water	25—43	50.4	50	Done up.
(2) "Triumph Superb"	Air	26—24	50.4	56	Done up.
(3) Newer high speed	Water	12—42	49.7	24	Done up.
(4) Newer high speed	Air	12—18	50.4	25	Done up.
(5) "Triumph," ordinary quality	Water	7—00	50.1	13½	Done up.
(6) "Triumph," ordinary quality	Air	10—15	50.4	19½	Done up.
(7) Special high speed	Air	4—57	50.3	9½	Done up.
(8) Ordinary high speed	Air	4—10	50.4	8½	Done up.

TABLE 2. CUTTING FORGED STEEL (NOT ANNEALED) WITH THE NEW AND OLD HIGH-SPEED STEELS.

To sum up, the newer steels are regarded simply as a development of the ordinary high-speed steels. They are more costly in price, and although they will water-harden, this is not pressed, as great care is necessary. Again, higher cutting speeds are not at present advocated. In short, the newer steels make their claim on their greater endurance. They are of special value on hard materials, giving particularly good results on cast iron and hard steels, and obviously they are specially applicable to form tools, or wherever a shape has to be maintained. The figures alone would indicate that they range with the older high-speed steels, the qualities, from the cheapest brands of the latter to the dearest steels, showing a fairly steady progression.

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The Steel Makers and an Old Proverb

In connection with the unusual difficulty which we have had in obtaining information relative to the new English high-speed steels, for which there has been a universal demand which we are able to partially satisfy by an article published elsewhere in this issue, a curious situation has developed and a still more curious one bids fair to develop.

The announcement of these new steels by Professor Arnold appears to have been premature and very unwelcome by the steel makers because of the existence in their warehouses of large stocks of the older steels of which they feared the announcement would injure the sale. The new steels have been made and used to a limited extent for some time, but for the reason given the steel makers have shown a decided unwillingness to give out facts for publication.

It now appears that a somewhat similar condition exists in this country, as it is an open secret that, for some time, tool steels have been in use in the shops of steel makers which are far superior to any steel that an outsider can buy from the same makers.

While the working off of the old stocks will take care of itself in due season, there is, however, serious reason to fear that the steel makers will continue to discourage the sale of the new steels, because, paradoxical as it may seem, they are too good.

Unlike the capacity for increased cutting speeds which formed such a spectacular feature of the original high-speed steel when it first appeared, the commanding feature of the new steels appears to lie in their durability and this is where the shoe pinches the steel maker. If the fragmentary accounts which reach us are to be believed, some of these steels maintain their cutting edges for an almost incredible length of time. This, of course, means that the tools need regrinding and reforging at rare intervals, and since it is the grinding and forging which really consumes the steel of which tools are made, these steels, by their very merit, bid fair to seriously reduce the tonnage sold. In other words, the steel makers are confronted with the fact that every sale of the steels cuts down the future demand, the sale being thus a case of killing the goose which lays the golden egg.

This is a condition which has occasionally arisen before, in minor degree, in connection with machinery of a kind which wears out rapidly, and we have known of cases in which manufacturers of machinery have been fairly confronted with the problem of the advisability of improvements because of their influence in reducing the demand for repairs. We doubt, however, if such an extreme case as the present one has ever arisen before, and it may fairly be called extraordinary. It certainly will be extraordinary if an improvement of this importance should be permanently shelved because unprofitable to those who have made it.

Postage to Germany

Since the going into effect of the 2-cent rate on letters to Germany, our attention has been several times called to the delays which take place in connection with such letters, and the matter has now been officially cleared up by correspondence between the American Hardware Manufacturers' Association and the postmaster of this city, from which it appears that "the 2-cent rate applies only to letters despatched by steamers able to carry such letters from the United States to German ports. It does not, however, supersede the Postal Union rate for letters to and from Germany, for the latter rate is still applicable to letters transhipped and forwarded via other countries. Letters prepaid at the 2-cent rate or less and despatched by a steamer calling at English or French ports en route to Germany are not transhipped via England or France, but carried through to Germany; whereas letters despatched by the same steamer and prepaid more than the 2-cent rate are forwarded via England or France—the quickest route."

The meaning of this, as we understand it, is that since steamships sail for England more frequently than for Germany, in cases when a letter prepaid at the 2-cent rate misses an outgoing steamer for Germany it is held up for the next, whereas if prepaid at the 5-cent rate it goes on the first steamship for England and thus arrives at its destination more quickly than those prepaid at the 2-cent rate.

Usable Engineering Data

In a recent paper by Doctor Nicolson occurs this paragraph: "In his [Doctor Nicolson's] experience he found that for any scientifically demonstrated physical fact to be made use of by engineers it must be capable of expression by a comparatively simple formula."

This quotation expresses an important and much disregarded truth. The advantages of simplicity are preached in discussing machine design and are promptly overlooked when stating facts upon which that design is to be based.

Some investigators seem to delight in stating the results of their labors in complex formulas and equations, instead of carrying their work a little farther and presenting usable data. The average engineer cannot be criticized for objecting to interminable mathematical expressions, perhaps containing progressions, summations, or similar terms, many of which

can be discarded and still give a result more accurate from the mathematical side than many of the assumptions upon which the original quantities were selected. Yet, in order to simplify such expressions the engineer must spend an amount of time out of proportion to the results obtained; therefore, he uses other methods and valuable data remain buried.

Some of the papers presented to our own Society of Mechanical Engineers are not above improvement in this direction. It is to be deplored that many investigators who are superbly endowed to carry out original research, lack the practical turn of mind to guide them to present their results to others in the simplest terms that can be devised for the purpose. In such simple forms their data would reach and be used by the greatest number, to the good of all. Many such investigators need a commentator, a simplifier to expound their teachings. This suggests one of the greatest fields of usefulness of engineering handbooks; that of adapting technical data to everyday needs.

We appreciate that probably nothing can be said to improve this general situation, but it is a pleasure to note the practical turn of mind of the able investigator from whom we have quoted.

Matthew Morton

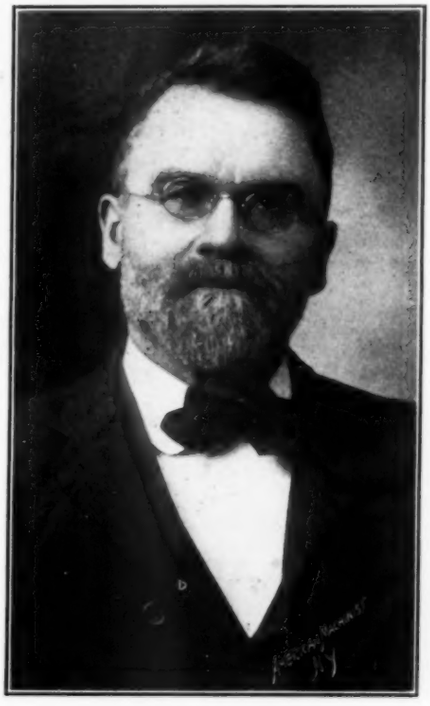
Matthew Morton, founder and president of the Morton Manufacturing Company, Muskegon Heights, Mich., and father of the draw-cut shaper, died at his home in that city on March 10 after a brief illness.

Mr. Morton was born in 1836 in Scotland, and when but eight years old was brought to this country by his parents. The family settled on a farm in Macomb county, Mich., and it was here that young Morton first began his mechanical career. On his way to market in Romeo, a city seven miles distant, he would frequently visit a small machine shop and spend a little time there making parts for a small foot lathe, which he would bring home and store in the woodshed. After collecting the necessary parts he finally assembled and completed the lathe, which at the time displeased his folks, for they did not favor his becoming a mechanic.

At 21 he moved to Armada village with his foot lathe and started in business, a year later moving to Lapeer, Mich., engaging in the steam-engine business under the name of the Lapeer Steam Engine Works. In 1861 he constructed his first steam engine. He made the patterns, molded them, melting the iron in a home-made cupola, machined and erected it entirely unassisted. His business grew and he established a record for building engines of economical steam consumption. After five years' partnership with the late William McDonald he disposed of his interests in Lapeer to Mr. McDonald and established a steam-engine business in Romeo, here building his first marine engine, which was very successful. In 1878, in partnership with A. Hamlin he went into the agricultural implement manufacturing business, but trade depression and financial reverses caused him to again start in business on a foot lathe, which was the start of the present plant.

In a short time he produced the first successful keyseater to cut with a single tool, and it proved to be the correct principle. In 1887 he developed the Morton portable slotter and planer, the first machine to be used in the Pittsburg district for planing the feet and windows of roll housings, which proved valuable for heavy work, best attested by its large sale.

In 1891 the factory was moved to Muskegon Heights, and in the same year incorporated under the name of the



MATTHEW MORTON

Morton Manufacturing Company, with Mr. Morton as president.

A passion for mechanics and the development of new ideas and improvements in machinery characterized Mr. Morton's life as is shown by the fact of starting his draw-cut shaper with a 26-inch stroke as the first product in this line, and developing it into the largest traveling-head shaper or planer in the world. During his lifetime he had taken out over forty patents which have nearly all been for useful machines and appliances and was always original in his ideas.

He was a man of strong character and honest convictions, his motives in both business and private life always being actuated by a desire to do right.

With the esteem and respect of all those with whom he came in contact, cherished at home and honored in business, his life is an example of work well done.

William Henry Wahl

William Henry Wahl, scientific journalist, metallurgist and electrochemist, died in Philadelphia, Penn., March 23, aged 61 years. He was born in that city and graduated from Dickinson College, later taking a course in chemistry and metallurgy at Heidelburg, Germany. He was engaged for many years as a teacher, editor and writer on technical subjects. He was best known as secretary of the Franklin Institute of Philadelphia, a position which he held from 1870 to 1874, and from 1882 to 1908, when he resigned on account of ill health. Doctor Wahl was connected with several technical journals; for two years, about 1880, he was on the staff of the *Engineering and Mining Journal*. He was also the author of several books, chiefly on chemistry and electricity.

Personals*

F. Schkommodan and M. Brechtel, of the engineering staff of Alfred H. Schütte, who have been spending several months in this country on business, returned to Europe on March 30.

D. B. Bullard, mechanical engineer, of the Bullard Machine Tool Company, delivered an interesting address before the Society of Mechanical Foremen of Bridgeport on modern machine tools and their development.

J. F. Jones, formerly of the transformer department of the Fort Wayne Electric Company, has accepted a position with the Wagner Electric Manufacturing Company, St. Louis, Mo., in connection with the same department.

P. E. Montanus, president, Springfield Machine Tool Company, and secretary National Machine Tool Builders' Association, returned on the "St. Louis," March 27, after a two months' trip through Europe. Mrs. Montanus accompanied him on the trip.

Henry E. Paine, formerly with the Walter R. Horning Company, has recently become connected with Hughson & Merton, Inc., San Francisco, and will be in charge of a new department created to handle a number of accounts for Eastern manufacturers of electrical lines.

Sidney G. Koon, until recently editor of the *International Marine Engineering*, has associated himself with the Jones & Laughlin Steel Company, in which position he will engage upon experimental work in connection with 200-ton open-hearth steel furnaces operated on the Talbot system.

*Items for this column are solicited.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

48-inch Special Five-spindle Milling Machine

The halftones show a special milling machine built by the Bement works of the Niles-Bement-Pond Company. Fig. 1 illustrates the machine with facing cutters in place and Fig. 2 shows the slab-milling spindle and cutter. The machine has one head on each upright, one horizontal slabbing spindle and two vertical heads on the cross rail. The drive and feeds are derived from a motor of approximately 40-horsepower rating, with variable speed, mounted on a separate base, attached to the back of the left-hand upright, and geared direct through spur gearing to the horizontal driving shaft.

For the horizontal slabbing spindle and the horizontal spindle on the left-hand upright, power is taken from the horizontal driving shaft through bevel gearing to the vertical splined shaft.

The horizontal slabbing spindle is driven from the vertical shaft through gearing including reversible change gear, giving a range of speeds from 8 to 30 revolutions per minute. The spindle is of high carbon steel and 9½ inches in diameter. Cutters can be used up to and including 16 inches in diameter.

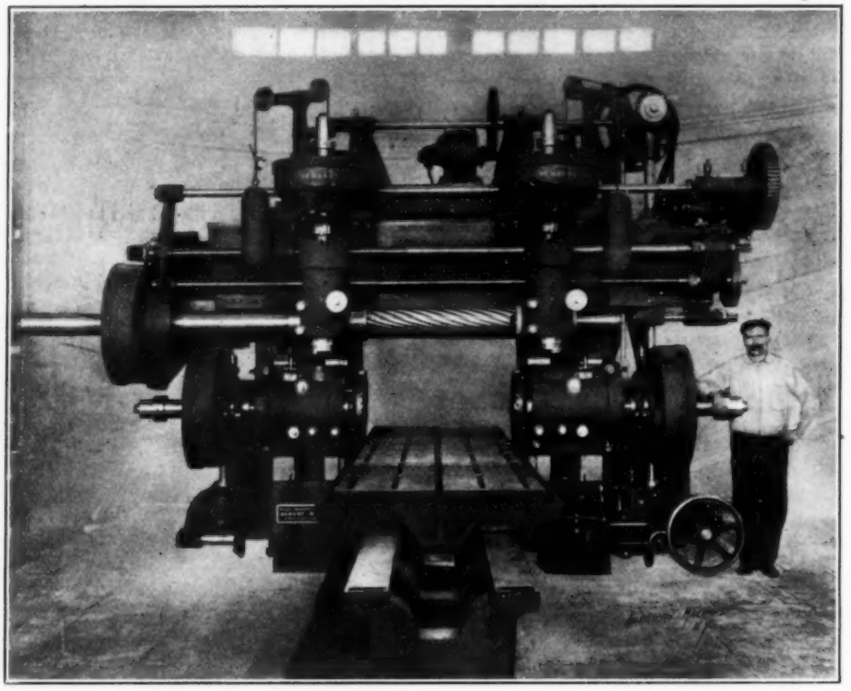


FIG. 2. FIVE-SPINDLE MILLING MACHINE WITH SLABBING CUTTER IN POSITION

The horizontal spindles on the uprights have a range of speeds of from 8 to 23 revolutions per minute. These spindles are 9½ inches in diameter, and arranged to take 16-inch or 20-inch diameter face mills for ⅝-inch square tools, and can be started or stopped by means of a positive clutch. They have a 10-inch horizontal adjustment by hand with minimum distance between them of 28 inches. The saddles have ample bearing on the uprights, are counter-weighted, and are adjustable vertically by hand, or may be connected to the cross rail for elevation by power. The vertical adjustment is 19½ inches.

The vertical spindles on the cross rail have a range of speeds from 8 to 42 revolutions per minute. These spindles are 7½ inches in diameter, and like the horizontal spindles just referred to, are arranged to take 16- or 20-inch face mills with ⅝-inch square tools, and can be started or stopped separately by positive clutches. Both of the vertical spindles are counterweighted, have 8-inch vertical adjustment by hand, and are so arranged that the left-hand spindle can be moved out of the way to enable the right-hand spindle to travel the full width between uprights by hand or power. The minimum distance between these spindles and the table is 11 inches; the maximum distance 38½ inches.

The cross rail carrying the vertical spindle saddles has a wide face inclined

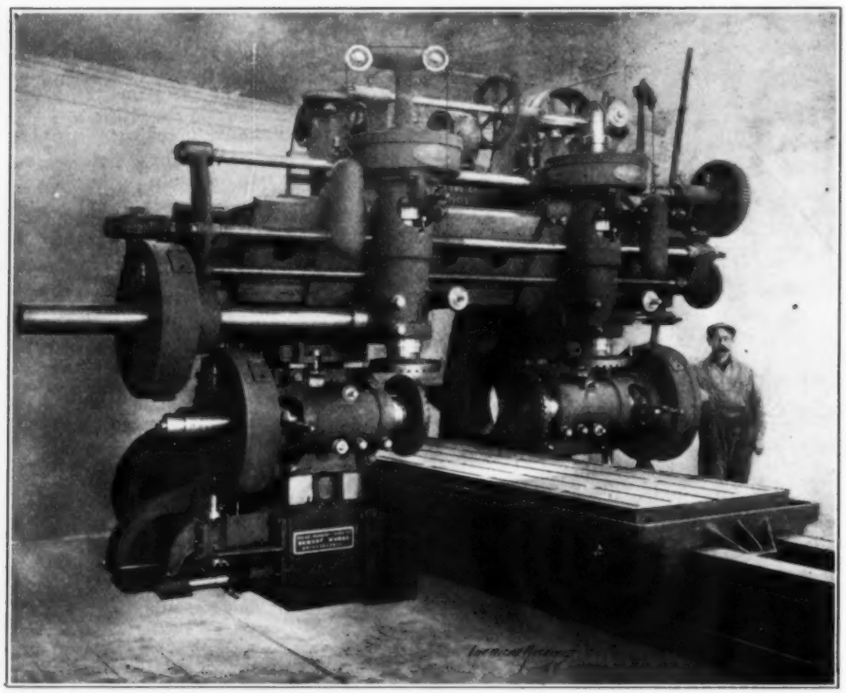


FIG. 1. FIVE-SPINDLE MILLING MACHINE WITH FACING CUTTERS IN PLACE

from the perpendicular, has long bearings on the uprights, is counterweighted and can be raised or lowered by a motor, mounted on top of the tie piece. Fine adjustment of the rail for hight is obtained by means of a ratchet on the end of the cross rail operated through bevel gearing connecting with the elevating mechanism.

The uprights are of box form with liberal width of face and depth, and extend to the floor line; they are rigidly secured to the bed by tongue and groove. The clear width between uprights is 49½ inches.

The table has a working surface 14 feet long and is provided with T-slots for holding the work; it is of deep section over the shears, and is provided with a channel along the sides to catch and drain off the lubricant. It is provided with eight automatic positive gear feeds, with a maximum rate of 7.6 inches per minute, and has fast power traverse in either direction and fine hand adjustment as well. From the end of the horizontal driving shaft extending across the bed, the feed is taken through spur and bevel gearing to a spiral pinion of coarse pitch meshing with the table rack, a worm and worm wheel being introduced in the feed train to prevent any slipping due to the thrust of the cut. Hand movement of the table is derived through the medium of a hand wheel on the end of the feed shaft, motion being transmitted through the same course as the power feed.

The bed is of box form extending to the floor, with frequent cross girts forming a rigid casting; it is of liberal width on the top, the table being held to place and guided by square locks and gibs. A complete circulating system is provided, the cutting fluid flowing into a large trough attached to the driving side of the bed, to a tank in the rear of the machine from which a power-driven pump forces it into a tank which is cast in the tie pieces between the uprights, and fitted with piping leading down to the cutters.

American Crank Shaper

This is a new design of a back-geared shaper, embodying several interesting features. The feed has been changed, can be adjusted accurately as desired and always shows just where it stands. It can be changed while running to give anything between 0.008 and 0.2 inch, there being 25 notches, each representing 0.008 inch feed.

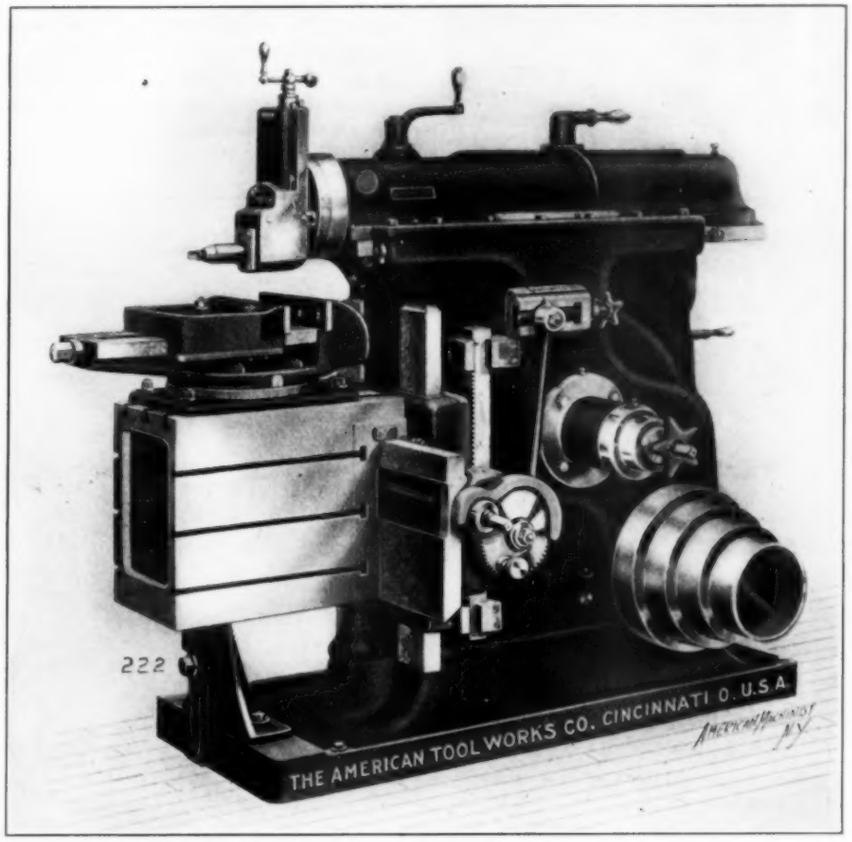
The stroke of the ram is positive and eight changes of speed are available, ranging from 7.7 to 96 per minute. The position of the ram is controlled by the handle near the head, which can be operated while running, while the index at the side shows the stroke for which it is set. The machine can be readily changed from single or open gear to back gear by a convenient, self-locking lever and when back geared, has a ratio of 24.3 to 1, making it well adapted for very heavy work.

The head swings to 100 degrees, has a continuous taper gib on the down slide, feed screw reads to 0.001 inch. A patented automatic stop releases the feed and prevents breakage if tool drops into a heavy cut, or the apron feeds to the end of its travel. The opening in the column allows 3½-inch shafting to be keyseated in this way. Lubrication has received considerable attention. The ram slides have felt wipers at both the front and center of column, which keeps oil from running down the machine. Oil pockets are provided in the center from which felt wipers distribute the oil through grooves to the extreme ends of slides.

Depth of Cut.	Feed Per Stroke.	Cutting Speed, Ft. Per Min.	Back Gear Position.	Revolutions of Cone.	Length of Cut.	H.P. at Tool.
¼″	0.080″	11.4	in	157	13½″	2.65
″	0.160″	16.3	in	225	13½″	7.07
″	0.200″	11.4	in	157	13½″	6.19
Abo	ve test m	ade in	cast	iron,	close g	rained,
18″	stroke.					
¼″	0.080″	11.4	in	157	14″	6.19
″	0.096″	11.4	in	157	14″	7.07
″	0.080″	11.4	in	157	14″	9.43
Abo	ve test m	ade in	mac	hiner	y steel,	very
tou	gh, 21″ s	troke.				

TEST SHEET—21″ B.G. SHAPER.

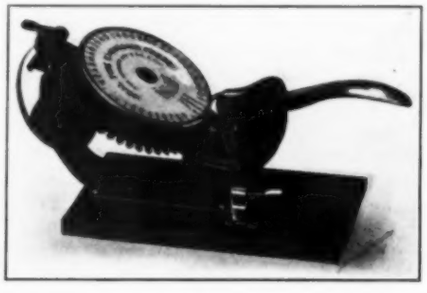
The following test of a 21-inch back-geared shaper gives a good idea of the work that can be handled, the feeds and speeds used and the power required. The shaper is made by the American Tool Works Company, Cincinnati, Ohio.



BACK-GEARED CRANK SHAPER

A Small Name Plate Machine

The use of embossed letters on patterns, on machine tools for classification purposes and in stock rooms seems to be increasing and the Roovers Manufacturing Company, Brooklyn, N. Y., has brought out a new machine for small work. This makes letters one-eighth inch high and is sold at a price that makes it available in any shop having use for it. They are also bringing out a new machine which will



SMALL NAME-PLATE MACHINE

emboss letters three-quarters of an inch high. The compactness and simplicity of the small press is shown by the engraving.

Two Machines for Automobile Shops

The Newton Machine Tool Works, Philadelphia, Penn., have brought out a splining or keyseating machine with both horizontal and vertical spindles that is being used quite extensively in automobile and similar work. Figs. 1 and 2 show this being used both ways, the horizontal cutter being generally used to take the length of the cut while the vertical spindle cuts out the ends. This is a very substantial machine, having a horizontal spindle 3 inches in diameter and a bearing 17¼ inches long. A 3-step cone is used to give the speeds through gearing. The vertical spindle is 1½ inches in diameter and is driven by miter gears. The work table is 9 inches wide, 44 inches long, and has a 24-inch feed with automatic release.

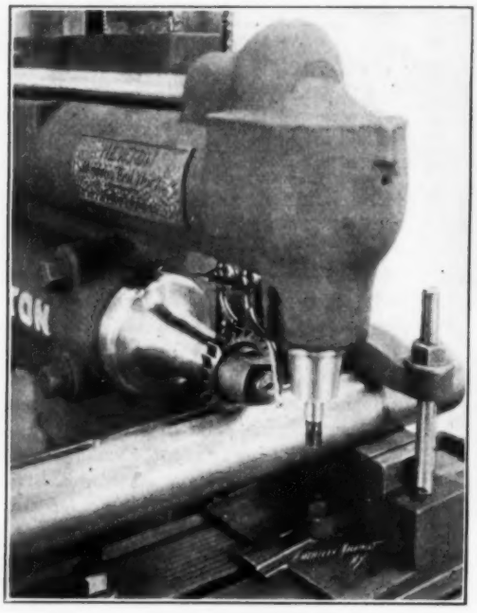


FIG. 1. MILLING KEYWAY

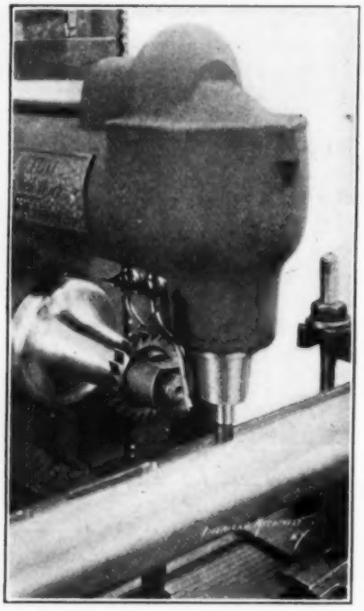


FIG. 2. ROUNDING THE END OF SLOT

The V-block shown in Fig. 1 is adjusted by a wedge to handle work of different diameters. Stops are fixed for different diameters so that it is an easy matter to locate the shafting centrally under the cutter, then the table is moved against outer stops that bring it in line with the vertical spindle for cutting out the ends of the keyway. The power feed has automatic stops so that duplicate keyseats can be cut without difficulty. It is fitted with cutters and washers for six keyseats from ¼ to ¾ inch in width. The spindle saddle is counterweighted and the arm carrying the vertical spindle acts as a reservoir for lubricant.

Cylinder Boring Machine

The spindles of this machine are 3 inches in diameter and revolve in brass-bushed capped bearings 20 inches long. The spindles are driven by means of steep lead-bronze worm wheel and hardened-steel worm, both in oil, through spur gearing by a cone giving four changes of speed. The large spur gear on the end of the worm shaft has a very heavy rim and acts as a flywheel, steadying the spindle drive and eliminating chatter. The spindle heads have hand cross-adjustment with micrometer readings and the adjacent faces of the heads have finished surfaces for spacing blocks to give the correct center distances to the bore of the cylinder. The driving worms are made of sufficient length to permit of this adjustment.

The work table is 24 inches square, has a 14-inch hand cross-adjustment while the saddle has an in-and-out adjustment by means of the hand wheel and a power feed of 14 inches. There are four changes of power feed taken directly from the end of the driving worm. As illustrated in Fig. 3, this machine is arranged to hold the boring bars by means of the four bolts shown to accommodate bars for boring open- or closed-end cylinders as desired. When open-end cylinders are to be finished, it is convenient to use an outboard bearing. In boring cylinders in multiples of four or six it is a usual custom to bore alternate cylinders, adjusting the table for the different sets. The cylinders to be bored are attached to the face plate mounted on the table, usually having a pin or plain surface for location, eliminating extensive stock of fixtures and expense of boring bars.

Crankshaft Grinder

The grinding of crankshafts for automobile and other small engines has reached such proportions that the Tindel-Morris Company, Eddystone, Penn., are putting out the machine shown herewith. It embodies the principal features of their crankshaft lathe and can grind any variety of crank, eccentric, taper or plain journal work. This requires no special fixtures for offsetting the cranks to the desired position as any number of varying centers can be had by two simple movements. The compound chuck which accomplishes this is seen in Fig. 2, showing the graduations of the chuck and the method of holding the work. This chuck accommodates any number of crank pins, no matter what the angle.

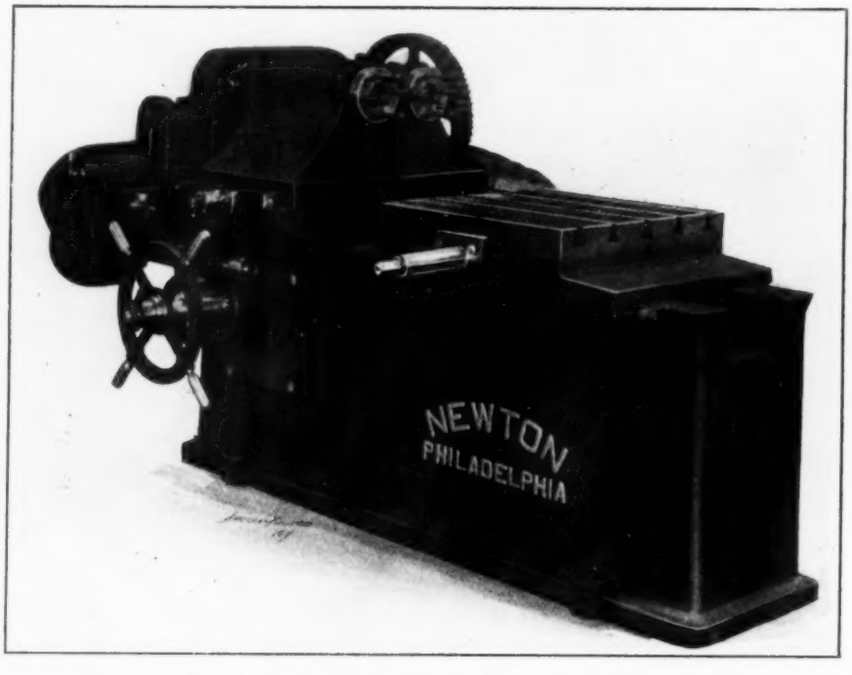


FIG. 3. AUTOMOBILE CYLINDER BORING MACHINE

The headstock and tailstock are both adjustable, both carry face plates and dead centers and are perfectly adapted to plain grinding, straight or taper, as well as to crankshafts. Both face plates are driven by one shaft so that it is unnecessary to turn the work end for end so as it can be driven from either end or from both ends. One headstock has an adjustable center, as shown in Fig. 3. The spindle is entirely independent of the face plate. No springs are used, but to prevent springing the work a coarse pitch screw is used which has such a small nurled head that it is impossible to secure sufficient pressure to do damage.

Counterbalances are provided for the back of each face plate to insure steady running of crankshafts and eccentrics. The face plates can be swung free of the driving pinions to adjust the counterbalances to the right position. A very heavy saddle is provided for the grinding wheel, and is locked square underneath the slides. A counterweight is provided which keeps the carriage in constant contact with the feed gear to take up wear and prevent backlash. The wheel arbor is nickel-carbon steel, hardened and ground, with taper bearings in phosphor bronze sleeves, which are split for adjustment. The headstock has a micrometer adjustment of the slide so that it can be moved as little as necessary to allow for the wear of the wheel.

A wheel dresser is mounted on the

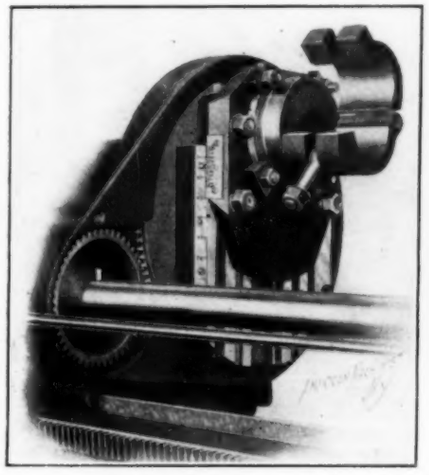


FIG. 2. THE CHUCK USED TO HOLD WORK

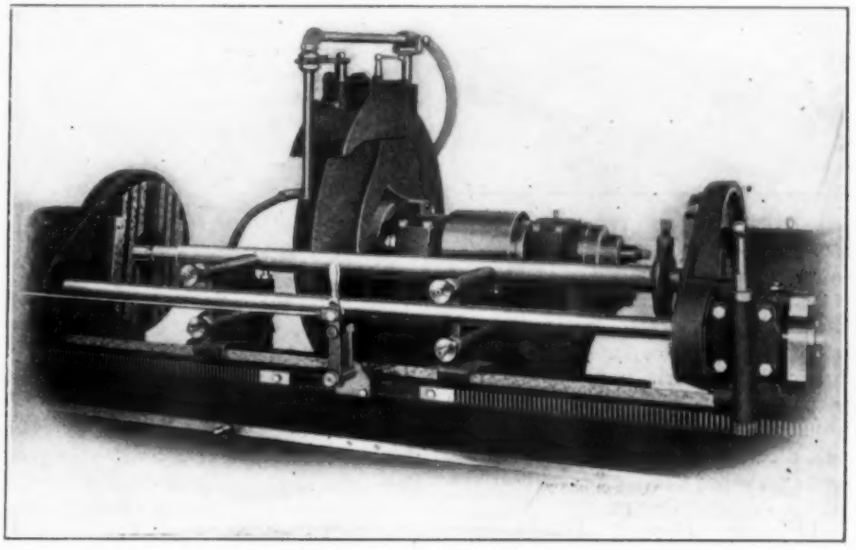


FIG. 3. USED FOR PLAIN GRINDING

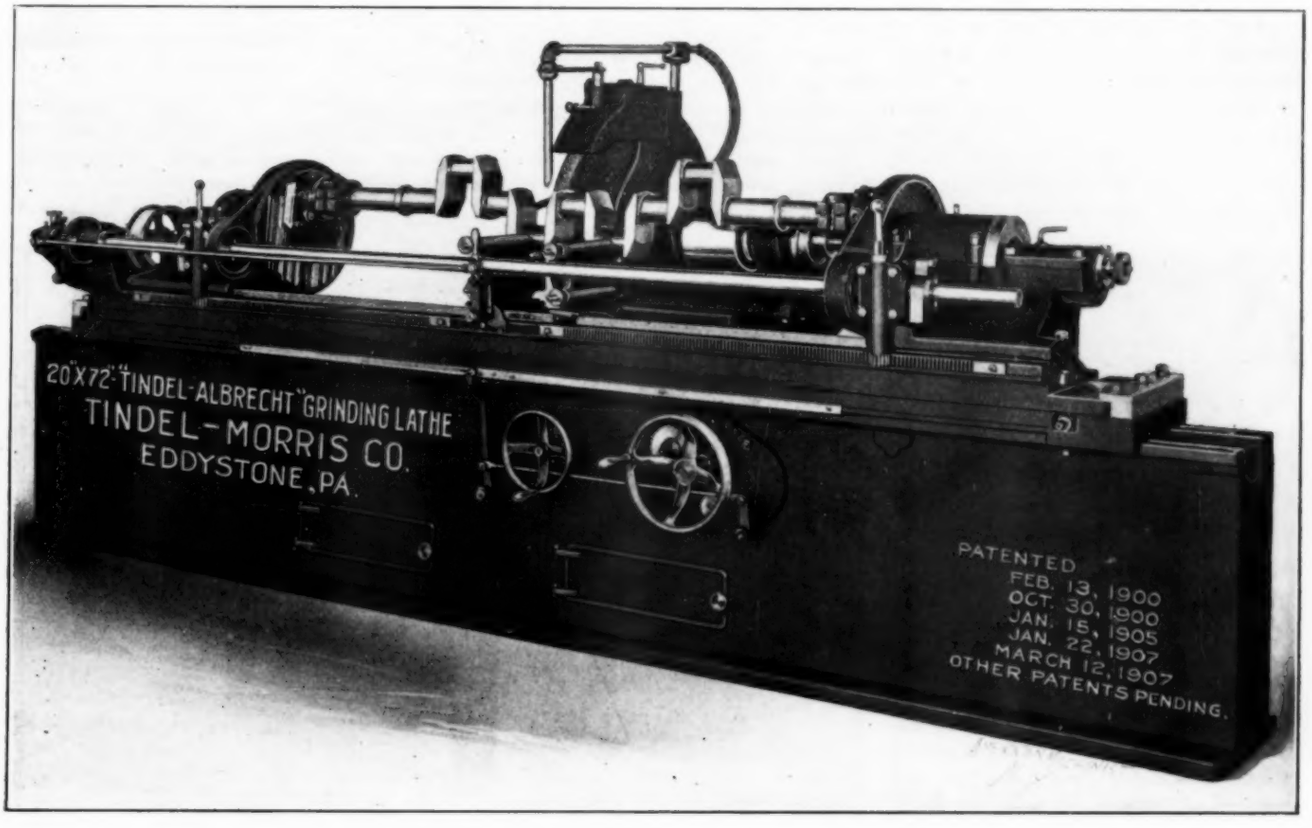


FIG. 1. THE TINDEL-ALBRECHT CRANKSHAFT GRINDER

work table and can be used to dress the wheel square, or by swiveling, to dress the corners for any desired fillet. Two compound rests, capable of fine adjustment are provided for long or slender work. A pump floods the work to pre-

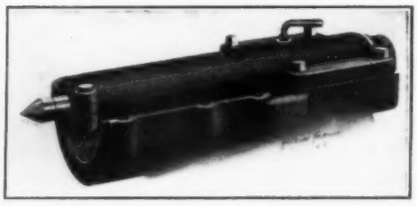


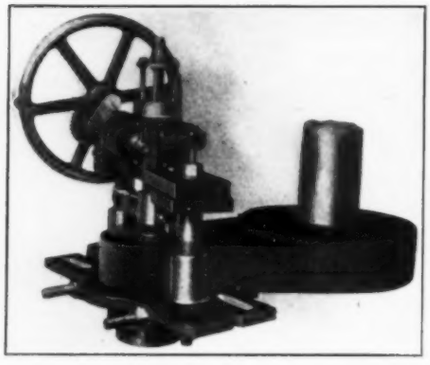
FIG. 4. THE ADJUSTABLE CENTER

vent overheating. There are 16 changes of table feed on five speeds to the face plates. The general construction is heavy to insure rigidity and to absorb the vibration. Automatic stops are provided for power traverse of table. There is also a sensitive hand traverse for short work, and for grinding between shoulders. The traverse ways have roller oil bearings.

A Universal Boring, Turning and Facing Machine

In the large number of repair cases handled by H. B. Underwood & Co., Philadelphia, there has arisen an urgent demand for a machine to cut out the riveted overhead of crank pins when it became necessary to remove them as is often the case. This led to the design of the tool shown herewith, which not only saves a lot of chipping in such cases, but has a much wider field of usefulness than might appear at first glance.

It consists principally of a slotted crosshead which forms the base of the machine and a casing containing a worm wheel made with large hubs to reduce wear. A cutting spindle slides through this worm



UNIVERSAL BORING, FACING AND TURNING MACHINE

wheel, having a 4-inch range of feed adjusted by hand. This spindle carries a steel cross-slide for the cutting tool and allows of adjustment for different diameters, with a maximum of about 12 inches.

Two slotted crossheads center the work and clamp it, being pulled together by two 1-inch through bolts. Two adjustable spacing blocks are provided which can be used to straddle different diameter cranks, locomotive wheels, or other work. Bolts through these blocks clamp the machine to the crossheads.

The machine is light enough to be handled by one man, has three changes of speed, and by means of an extra attachment can be used to face pump- or engine-valve seats almost without regard to their construction. The machine can be driven either by hand or power according to conditions.

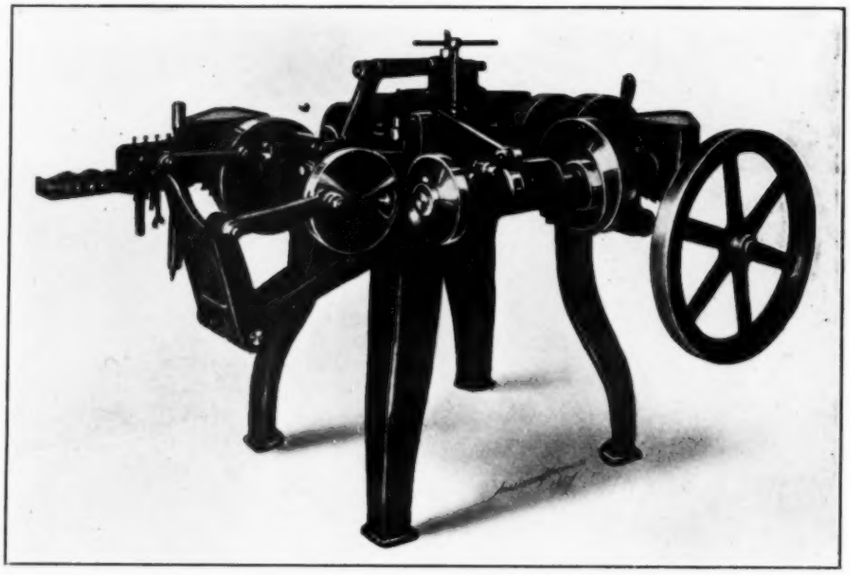
An Automatic Wire Forming Machine

The halftone shows a wire-forming machine of the four-slide type which has recently been brought out by the Baird Machine Company, Oakville, Conn. In this machine the designer has endeavored to make the parts as accessible as possible.

The wire first passes through the straightener, which, in this case, forms a part of the machine. The feed mechanism is simple, easily adjusted, and is provided with positive stops insuring accurate feeding. The cut-off is secured by a single-clamp bolt. With this machine, either a stationary or a moving form can be used.

A friction-clutch pulley is provided on this machine obviating the necessity of a countershaft and permitting the machine to be run at a slow speed when setting up and trying new forms, so that the operator can watch the movements. All adjustments are within easy reach of the operator.

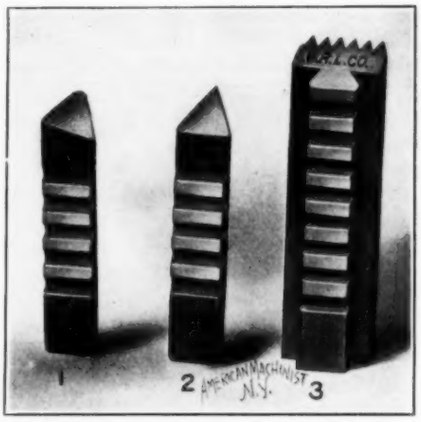
These machines are built in six sizes handling wire up to ⅜ inch in diameter by 15 inches long.



AUTOMATIC WIRE-FORMING MACHINE

Tools for the Lang Holder

The illustrations show three types of tool to be used in the Lang tool holder shown in a recent issue. Tools 1 and 2

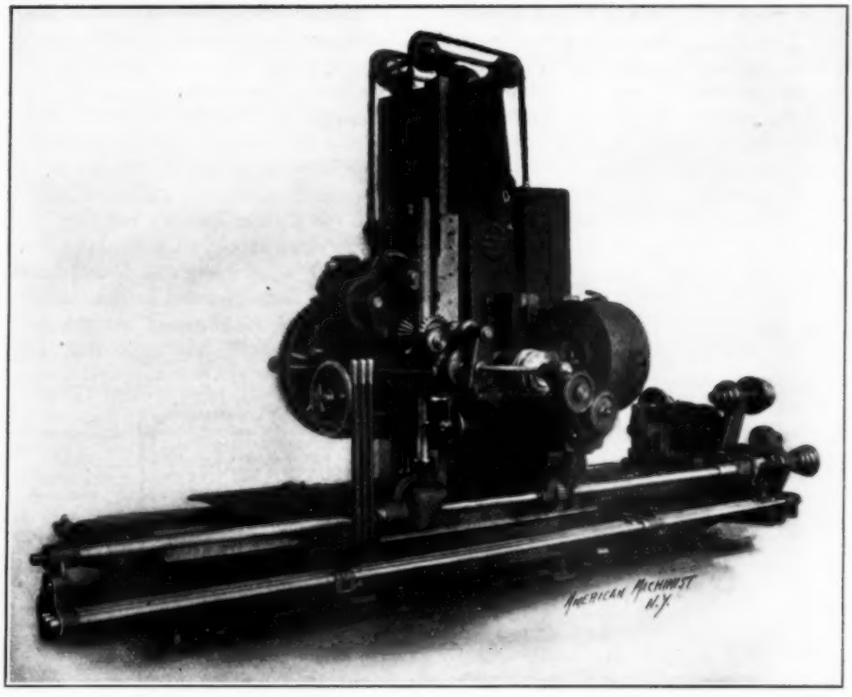


TOOLS FOR THE LANG TOOL HOLDER

are made from stock drawn in a triangular shape, while tool 3 is a chaser for finishing threads. Although this is a special shape it can be held and adjusted in the holder as readily as the others. The triangular steel can now be had in commercial bars, ready to use, so that new tools can be quickly made to fit any of these tool holders. They are made by the G. R Lang Company, Meadville, Penn.

A Large Portable Boring Machine

Portable tools have changed greatly since the days when the ratchet drill and the "old man" constituted the only portable machine, and we now have machines of various kinds which weigh tons instead of



LARGE PORTABLE BORING MACHINE

pounds, picked up by the crane and deposited anywhere in the shop.

An interesting example of this is the large horizontal boring machine made by Beaman & Smith, Providence, R. I., and shown in the accompanying illustration. It has the main characteristics of their regular boring machines, has a 5-inch spindle, and weighs 31,375 pounds. It is carried by the crane to any part of the shop that has work needing such a machine, and lowered on the concrete floor or bed plate as the case may be.

Casters for Punch and Die Trucks

By W. E. Dan

In the accompanying sketch is shown a truck caster differing in size and a few details from the ordinary caster sold on the market. These casters were designed for trucks for carrying heavy punches and dies from the storeroom to the press room, tool room, or other parts of the factory. As a precaution against fire the dies are kept in a building apart from the general manufacturing plant, and at no time are they out of this building excepting when in work, or when repairs are necessary, etc.

A special table is made for each pair of dies, and a few words about these tables may be of interest. These punches and dies weigh from 500 pounds up to 2300 pounds, and consume from one to 10 weeks to make. An order is given to the die foreman for a set of dies, also one to the carpenter for a truck as per the dimensions in the order. When completed the truck is delivered to the tool or die room where it is used as a bench on which to construct the dies. This keeps the workman's bench clear of castings, etc., and makes it possible to place the work so as to get the best light. When the dies are finished they, together with the truck, are delivered to the store room where they remain until taken out to the press room.

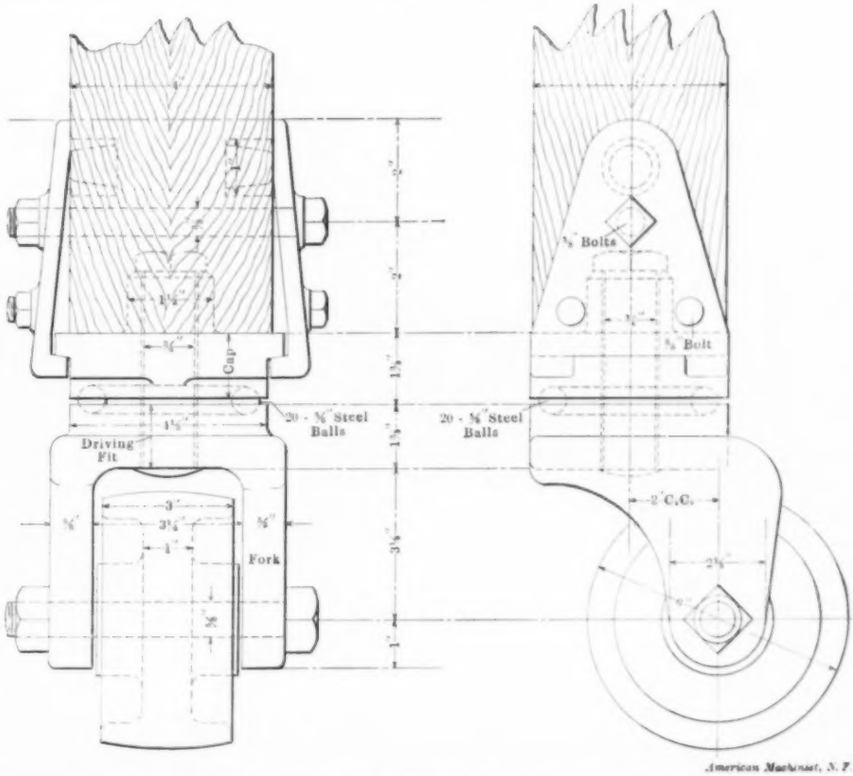
The legs of the truck are 4x4 inches, the braces 1½x6 inches, and the top 2 inches thick. These are all of Georgia pine. The top, or table, is covered with sheet iron, and the top of the table is exactly level with the top of the press in which the die is used. This makes the work of changing from one to the other easy.

The "caster" is cast iron. The roller is 6 inches diameter, 3 inches wide, and crowning, with a *chilled* face. A few remarks regarding casters of this style may be of interest. This factory has acres of cement floor, about 200 trucks of all kinds are in constant use, and outside of emery there is nothing I know of that will cut down the flange of a truck wheel as will this cement floor. For this reason the crowning faces of these caster wheels, or rollers, are chilled.

Another detail is the distance from center to center of the roller and swivel. This is made 2 inches and answers every requirement of a caster of this size much better than if the lines of the regular caster was followed, which in this case would be 3 inches center to center, or the vertical center line of the swivel would drop tangent to the periphery of the wheel.

The swivel bearing is made up of twenty ⅝-inch steel balls, and the space between the cap and fork is 1/32 inch only. The purpose of this is to keep out dirt as much as possible.

The method for clamping or securing the caster to the bottom of the 4x4-inch legs is new and is clearly shown. The side plates have a 1x1-inch boss which fits holes in the legs. The taper rib on the bottom matches a lip on the side of the cap, so that when the bolts are screwed up



CASTERS FOR PUNCH AND DIE TRUCKS USED ON CEMENT FLOORS

the tapers draw and secure the caster to the leg.

These casters have been adopted by other factories having cement floors, and they wear much better than the ordinary casters. Made according to the dimensions given, four of them will hold up two tons.

National Machine Tool Builders' Association

The regular spring meeting of the above association is announced for May 25 and 26, to be held at Milwaukee, Wis., with headquarters at the Plankington house.

Jasper R. Rand

Jasper R. Rand, vice-president and director of the Ingersoll-Rand Company, died of pneumonia in Salt Lake City on March 30. Mr. Rand was the son of Jasper Raymond Rand, one of the founders of the Rand Drill Company, and was born in Montclair, N. J., September 3, 1874.

He was graduated from Cornell University in 1898 with the degree of mechanical engineer, and served in Porto Rico in the Spanish-American war as a member of the First New York Volunteer Engineers. During 1899-1900 he was president of the Imperial Engine Company, at Painted Post, N. Y., leaving that position to take the presidency of the Rand Drill Company, which he held until 1905. In that year he was elected vice-president and director of the Ingersoll-Rand Company, which was his chief interest until the last.

Mr. Rand was a member of the Spanish War Veterans, of the American Society of Mechanical Engineers, the American Institute of Mining Engineers, the Engineers' Club and the Cornell Club, as well as connected with many public-spirited enterprises.

A Pneumatic Tool Holder for Tire Lathe

By W. A. Anthony

Some time ago there was installed in the Philadelphia & Reading Railroad Company's wheel shops at Reading, Penn., two 40-inch and two 90-inch tire lathes that were built by the Niles-Bement-Pond Company. As competition in turning out work is very keen, it seemed to me there was room for improvement. While observing the differences in the amount of work turned out, I started the designing and building of the automatic tool holder described below and now, with its help, one man, on one machine, is turning out more work in one day than in any other place in the world.

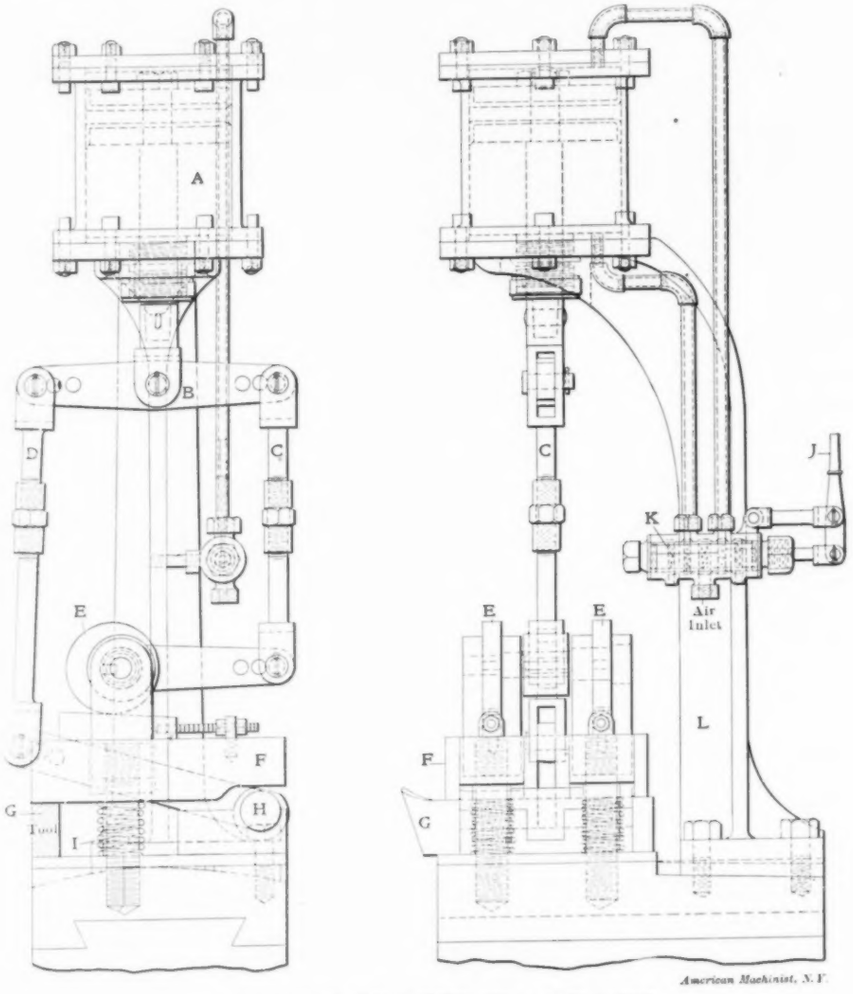
With an operator well broken in, we found it possible to turn out 10 pairs of 36-inch wheels in 10 hours, by using these machines as they were received from the builders. By placing a tool bench back of the operator so that he would not have to move to place his hand on any tool he desired; by putting on his tool rests a pair of removable two-way ratchets that could make a complete revolution, thus making adjustment of his tools an easy matter, and by making a pair of adjustable skids that could be used for any size axle, in putting in, and taking out, the wheels, we increased the output to 12 pairs of 36-inch wheels in 10 hours.

The operator then claimed that his only drawback, in turning out more work was the time and labor lost in putting in and taking out the tools. As five pairs of tools are used in turning one pair of wheels, not counting the tools knocked out by striking hard spots, you will see that the adjustment of tools consumed considerable time, and hard labor during a day's work. Each tool clamp has 4½-inch nuts to tighten with a 40-inch wrench, thus making a total of 80 nuts to screw and unscrew in the turning of one pair of wheels.

With this automatic tool holder the time and labor has been reduced to a minimum and one machine today is averaging 16 pairs of 36-inch wheels every 10 hours.

The design of this pneumatic tool holder is shown in the line cut. The air cylinder *A* is used with 90 pounds of air and pulls up the equalizing lever *B* and with it the eccentric rod *C*, thus causing the cams *E*, with a 7/16-inch throw, to push down the tool clamps *F* against the tool *G* and hold them there. The difference in the throws of cams *E* and *H* allows a margin for placing and removing the tools and also causes the eccentric rod *D* to pull up the cams *H*, with a 3/16-inch throw, and thus push up clamps *F* in the rear and down in the front. This acts as a wedge and pinch bar, making the tool unmovable with one movement of the hand on the air-valve lever *J*. The springs *I* lift up the clamps *F* when the air is released, allowing the removal of the tool with ease. The valve *K* is a four-way air valve that is used both ways. The housing *L* is cast steel and fastened to the tool rest with six ⅞-inch studs.

The rights to use this tool holder can be obtained from the author, Elizabeth, N. J.



A PNEUMATIC TOOL HOLDER FOR A TIRE LATHE

Forthcoming Meetings

Joint meeting of the four National Engineering Societies, Engineering Societies building, New York City, April 13. Conferring of the John Fritz medal upon Charles T. Porter.

National Metal Trades Association, annual meeting, April 14-15, New York City, headquarters Hotel Astor. N. W. Dingwall, secretary, Fourth National Bank building, Cincinnati, O.

American Society Mechanical Engineers, semi-annual meeting, Washington, D. C., May 4-7. Calvin W. Rice, secretary, 29 West Thirty-ninth street, New York City.

American Supply and Machinery Manufacturers Association, joint convention with Southern Supply and Machinery Manufacturers Association, Chattanooga, Tenn., May 5, 6, 7; headquarters, Hotel Patten.

National Supply and Machinery Dealers Association and American Supply and Machinery Manufacturers Association, joint convention, Pittsburg, Penn., May 12-13-14, headquarters Fort Pitt hotel. A. T. Anderson, secretary, Wade building, Cleveland, Ohio.

The Foundry and Manufacturers Supply Association, convention, Cincinnati, Ohio, week of May 17.

American Foundrymen's Association convention, Cincinnati, Ohio, May 18-20, headquarters Hotel Sinton. Richard Moldenke, secretary, Watchung, N. J.

National Machine Tool Builders' Association, spring meeting, May 25-26, Milwaukee, Wis., headquarters, Plankington house. P. E. Montanus, secretary, Springfield, Ohio.

American Hardware Manufacturers Association, joint convention with Northern Hardware Jobbers Association, Pittsburg, Penn., June 9-11, headquarters Hotel Schenley. F. D. Mitchell, secretary, 309 Broadway, New York City.

Railway Master Mechanics Association, annual convention, June 16-18, Atlantic City, N. J. Jos. W. Taylor, secretary, Old Colony building, Chicago, Ill.

Master Car Builders Association, annual convention, June 21-23, Atlantic City, N. J. Jos. W. Taylor, secretary, Old Colony building, Chicago, Ill.

Business Items

C. H. Stephan, formerly of Desmond-Stephan Manufacturing Company, Urbana, O., has formed the C. H. Stephan Specialty Company, Dayton, O., to make emery wheel dressers.

The Holyoke Belting Company, of Holyoke, Mass., is just moving into its new factory on Winter street, where it will have greatly increased facilities for taking care of its business.

The C. A. Lawton Company, De Pere, Wis., manufacturer of power transmitting, saw, paper and pulp mill machinery, has recently placed an order for a three-spindle Henry & Wright drilling machine, one sixteen and one eighteen-inch Prentice all-geared high-speed turret lathe.

The Dwight Slate Machine Company, Hartford, Conn., manufacturer of sensitive drills, automatic gear cutters, marking machines, etc. which went into the hands of a temporary receiver about a month ago, is in the market to sell the business and plant to someone as a running concern.

C. F. Hafley, formerly advertising manager for the Buffalo Forge Company, Buffalo, N. Y., and more recently with the Keuffel & Esser Company, Hoboken, N. J., has taken a position with the Vechten Waring Company, 92 John street.

The Robins New Conveyor Company has leased the entire building at 72 Front street, New York City, and on April 1 removed its offices to this new location. Greatly increased facilities are provided by the new location, particularly for the manufacture of Robins laminated leather belting and Robins genuine Balata belting.

Among the concerns who have recently ordered motors from Crocker-Wheeler Company are the following: Johnson & Johnson, New Brunswick, N. J.; Buffalo Copper and Brass Company, Buffalo; Frick Company, Waynesboro, Penn.; Eastwood Wire Manufacturing Company, Belleville, N. J., and the Cox-Clark Engraving Company, Barclay building, Denver.

Business Opportunities

The Manistee (Mich.) Iron Works will enlarge plant.

The Decatur (Ind.) Furnace Company will erect an addition.

The Detroit (Mich.) Radiator Company expects to build a new plant.

The Southern Pacific Company will erect car shop at Roseville, Cal.

The Samson Cordage Works, Shirley, Mass., will erect addition to plant.

A new foundry building is being erected for August Jeske, Milwaukee, Wis.

The Woodward Governor Company, Rockford, Ill., has made plans for a new plant.

The Tottenville (N. Y.) Copper Company has filed plans for a steel factory building.

The Royal Typewriter Company, Hartford, Conn., is said to be planning an addition to plant.

The plant of the Stuart Machinery Company, Winnipeg, Man., recently burned, will be rebuilt.

The Chicago & Northwestern Railway Co. will build a new roundhouse at Council Bluffs, Iowa.

The Rustin (La.) Hardware and Supply Company is preparing plans for a new grey iron foundry.

R. C. & H. B. Good, Newark, N. J., leather manufacturers, will build a $15,000 extension to plant.

The new plant which the Wright Wrench Company, Tacoma, Wash., is erecting, is nearing completion.

Plans for a new plant for the American Laundry Machine Company, Rochester, N. Y., have been prepared.

The sawmill plant of the C. D. Bridges Lumber Company, at Hurlbut, Ark., was burned. Loss, about $35,000.

The plant of the F. & N. Lawn Mower Works, Richmond, Ind., was destroyed by fire. Loss, about $100,000.

Byrne & Du Bois, machinists, Albany, N. Y., will erect a new machine shop for general machine and repair work.

It is reported that the Phillips Insulated Wire Company, Darlington, R. I., is planning a large addition to plant.

The Vichek Tool Manufacturing Company, Cleveland, Ohio, is erecting a new plant to replace the one recently burned.

The sawmill of the Ruddock-Orleans Cypress Company, Ruddock, La., was destroyed by fire, causing a loss of about $90,000.

McMillan Bros., of Mobile and Jacksonville, will establish a plant in Pensacola, Fla., for the manufacture of turpentine stills etc.

Contracts have been awarded for construction of new steel mills for the newly organized De Forest Steel Company, at Niles, Ohio.

The Gender, Paeschke & Frey Mfg. Co., Milwaukee, Wis., manufacturing enameled ware, will erect a three-story addition to plant.

The machine shops of the Cappel Fan and Engineering Company, Monongahela, Penn., were destroyed by fire, entailing a loss of about $100,000.

The California Saw Works, San Francisco, Cal., has prepared plans for two new buildings, one to be used as a machine shop and the other as saw factory.

New Incorporations

The Atlas Jewelry Company, Boston, Mass., has been incorporated to manufacture and sell jewelry of all kinds. Capital, $30,000. G. A. Menard, Attleboro, president.

The Milford Manufacturing Company, Irvington, N. J., has been incorporated with $50,000 capital. Incorporators, Andrew Volker, C. F. Meyer, etc. Will manufacture tools.

The Mt. Holly Iron Works, Camden, N. J., has been incorporated to engage in the manufacture of iron and steel. Capital, $10,000. Incorporators, J. A. MacPeak, F. R. Hansell, R. M. Johnson.

The Savage Stamping Company, Rochester, N. Y., has been incorporated to manufacture in brass, copper, zinc and other metals. Capital, $25,000. Incorporators, A. S. S. Swan, L. S. Foulkes, J. E. Booth.

The Sterling Gas Machine and Manufacturing Company, Camden, N. J., incorporated to manufacture carbureters, gas machines, etc. Capital, $25,000. Incorporators, L. C. Simpson, J. W. Mills, G. A. Darlington.

Sandblom Iron Works, Brooklyn, N. Y., has been incorporated to manufacture structural iron work and steel. Capital, $100,000. Incorporators, G. Sandblom, Brooklyn; L. U. La Cour, Flushing; J. T. Booth, New York.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith, Columbia, Penn.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Wanted—Machinery to manufacture on contract. Hydrostatic Machinery Co., Rochester, N. Y.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Wanted—A first-class Jones & Lamson turret lathe operator. Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.

Machines designed; automatic, special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Wanted—Second hand slotter, universal grinder; also cold saw grinder. Advise us what you have. Albro-Clem Elevator Co., Philadelphia.

Wanted—Punch press and jig work; good facilities for manufacturing of light articles. Models, dies, tools, etc., made. Joseph Pollak, 215 Sydney St., Dorchester-Boston.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Wanted—To purchase a machine capable of flattening plates of perforated metal having plain margins, the buckles arising from the stretching of the center of sheets where per-

forated. Address "Metal," care Morse Agency, 19 West 34th Street, New York.

In order to settle an estate an attractive opportunity is open to a party with $150,000.00, competent to fill responsible position either in the sales or manufacturing department, to purchase an interest in a well and favorably known, profitable machinery manufacturing plant located in Pennsylvania, with an office and established trade in New York City. Address "Executors," care of AMERICAN MACH.

English engineer who is in New York to sell American patent (the English rights of which have been purchased by one of the largest firms in Great Britain) is desirous of introducing sound American inventions on his return to England. Advertiser is capable of placing and controlling anything from a cycle spanner to a locomotive, having good connections with all the best and largest firms in England. Apply "E. T.," care Messrs. Marwick, Mitchell & Co., 79 Wall Street, New York.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Progressive up-to-date machine shop superintendent; successful organizer; reduce cost and increase production; executive ability. Box 92, AMERICAN MACHINIST.

DELAWARE

Mechanical draftsman, experienced principally on machine tools; now employed, wishes to change. Box 82, AMERICAN MACHINIST.

MASSACHUSETTS

Die sinker foreman would like to make a change; have had charge three years of drop forge die-sinking. Reference. New England preferred. Box 80, AMERICAN MACHINIST.

Wanted—Position as chief draftsman with small firm or assistant to chief with large firm, manufacturing medium weight machine tools or other machinery. Good designer with executive ability. Age 30. Box 86, AM. MA.

Position as foreman of machine shop or tool room by an American; age 30; married; 14 years' experience as machinist, toolmaker, draftsman and foreman; technical education; present position, tool designer. Box 90, AMERICAN MACHINIST.

Toolroom foreman; thoroughly posted on design, construction and care of precision machinery and tools for accurate production. Capable laying out complete plant for manufacturing small, close work. Twenty years' shop and drafting room. Box 81, AMER. MACH.

Factory manager or superintendent; young man, energetic, aggressive; experienced in manufacture of valves and plumbers' cocks; can get good work out of finishing shop and foundries; up-to-date methods of handling help and getting work out at low cost. Box 55, AMERICAN MACHINIST.

MICHIGAN

A competent man 35 years of age, with 15 years' experience in machinery and supply trade in New York, desires position with manufacturer or merchant as salesman or purchasing agent. Address "Vigilantia," Box 53, AM. MA.

Situation Wanted—As superintendent or shop manager; 20 years' experience manufacturing small interchangeable parts. Thoroughly understand shop organization, cost systems, etc. Can produce the maximum at the minimum cost. Am an expert on all kinds of piece work. Am 38 yeart of age and married. At present employed, but desire to make a change; good reasons given. Can furnish best of references. Will go anywhere if salary is right. Box 48, AMERICAN MACHINIST.

NEW YORK

Situation—Draftsman and designer on jigs and fixtures; ten years' experience; best references. Box 70, AMERICAN MACHINIST.

Wanted—Position as draftsman with a concern having an opening for a beginner with technical education; best of reference. Box 79, AMERICAN MACHINIST.

Draftsman, technical graduate, eight years' experience on automatic and special machines. Accurate, quick and neat. Best references. Address Box 29, AMERICAN MACHINIST.

Tool room foreman; a competent man who thoroughly understands blanking, forming, drawing and general sheet-metal work; age 40; earnest and steady. Box 94, AM. MACH.

Mechanical engineer, wide experience in building steam engines, explosion engines and compressor machinery, wishes position of chief engineer or general superintendent. Box 93, AMERICAN MACHINIST.

With suitable position assured, technical graduate, age 35, experienced in entire management small manufacturing plant, would invest in industry already on paying basis. Box 91, AMERICAN MACHINIST.

OHIO

Works manager or superintendent, by strictly first class man, extensive experience with large concerns; replies only from parties requiring a man in such capacity; no other position considered. Box 49, AMERICAN MACHINIST.

PENNSYLVANIA

Structural and mechanical engineer of experience as chief engineer and works manager wishes to change. Philadelphia district preferred. Box 85, AMERICAN MACHINIST.

Young man with 10 years' practical experience in factory costs, 5 years in charge of office and costs, desires position of office manager; correspondence solicited; age 30; married; will go anywhere if proper inducements are offered. Address Box 60, AMERICAN MACH.

Mechanical engineer, 31 years of age, of established reputation, technical education, 12 years' experience as designer, chief draftsman and superintendent. Expert on special machinery. Experienced and qualified to direct work and handle men. Understands factory and construction gang organization, shop production and economy. Is open for position as mechanical engineer or superintendent of construction; best of references. Box 54, AMERICAN MACH.

FOREIGN

Man, 42 years of age, with 15 years' experience as works manager, and 6 years' foreign sales manager, desires position as latter at London, with A-1 American engineering firm Thoroughly familiar with English and Continental business; up-to-date hustler. Box A. 3, AMERICAN MACHINIST, 6 Bouverie Street, London, E. C., England.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Wanted—Mechanical draftsman for jig and fixture work. Box 77, AMERICAN MACHINIST.

First-class draftsmen wanted; men experienced in tooling up turret lathes preferred; no one but first-class men need apply. Box 59, AMERICAN MACHINIST.

GEORGIA

Wanted—Pattern shop foreman of large general experience on patterns for both heavy and medium weight iron castings. State experience fully and give references. Shop modern and up-to-date. Address "Patterns," care AMERICAN MACHINIST.

INDIANA

Wanted—First-class toolmaker on jig and fixture work. No other need apply. Box 76, AMERICAN MACHINIST.

MICHIGAN

Wanted—Machine-shop foreman with wide experience in modern shop practice to handle and direct 150 men. Plant located in Middle West—building heavy sawmill machinery. Man with technical education preferred. Box 40, AMERICAN MACHINIST.

NEW JERSEY

Toolmakers wanted for sub-press die and fine close fitting interchangeable parts. Box 84, AMERICAN MACHINIST.

Man in metal department to take charge of 50 men; must thoroughly understand automatic screw machines, drawing presses, buffing and plating, and be up in modern shop practice; give full particulars. Box 71, AM. MACH.

NEW YORK

Draftsman Wanted—Experienced on textile finishing machinery preferred. Permanent position. Box 87, AMERICAN MACHINIST.

Wanted—Man familiar with repairing and erecting of steam engines and boilers; must be capable and quick. A fine position in New York City open to the right party. Address "H. W.," Box 58, AMERICAN MACHINIST.

Wanted—By large prominent printing machinery manufacturers, a first-class up-to-date general foreman, capable of handling men to best advantage; must be able to estimate closely. State fully age, experience, references and salary desired. Box 57, AMERICAN MACHINIST.

Foreman Wanted—Man under forty for machine shop with capacity for about forty hands; location, New York City; first-class, well educated machinist with executive ability; experience in gas engine work desirable. Address giving experience, age, references and salary expected. Box 89, AM. M.

Wanted—Foreman; age 28-35; first-class all-around machinist and draftsman, familiar with pattern shop and foundry practice, also experienced in manufacturing and using pneumatic equipment. Must have an inventive mind, and A-1 references. Permanent position and splendid opportunity for advancement with young aggressive manufacturing company. Box 88, AMER. MACHINIST.

OHIO

General foreman for machine room employing about 100 men on automobile work in northern Ohio. Man must have had experience with piece work plan and must be capable of turning the work out quickly and cheaply. None but those holding down similar positions at the present time need apply. Box 989, AM. MA.

PENNSYLVANIA

Wanted—Foreman for modern shop; must understand sheet metal die work; quick to originate means and get out work; state experience, age, references; shop of 20 men and boys; western Pennsylvania. Box 61, AM. MA.

RHODE ISLAND

Wanted—A first-class mechanical draftsman experienced on hoisting machinery. In reply state age, experience and salary expected. Box 78, AMERICAN MACHINIST.

For Sale

Latest type Cleveland 2¼-inch automatic screw machine. Good as new. Box 83, AMER. MACHINIST.

Valuable Canadian Patent—On labor-saving machine being rapidly introduced in the United States. Reynolds Machine Co., Moline, Ill.

Air Compressor—Ingersoll-Sargeant 10x10x10, class F, steam driven, 100 lbs. air pressure with 100 lbs. steam, 125 ft. capacity per minute at 150 r.p.m. Frst-class running condition (cost $800.00). Price $450.00 net. J. W. Paxson Co., Philadelphia, Pa.

For Sale—Well equipped general machine shop in New Jersey, employing 24 hands and now running 13 hours per day and with good prospects for the future. Good reason for selling. Investigation solicited. Address "R," Box 1216, New York City.

For Sale—The American rights of an invention that is required in every workshop, railway and tramway system. Over 30 licenses granted to manufacturers in Great Britain. The English patent has been purchased by the well-known firm of Messrs. Vickers, Sons & Maxim, Ltd. For further particulars apply "E. T.," care Messrs. Marwick, Mitchell & Co., 79 Wall Street, New York.

Automoblie testing plant; complete outfit of apparatus, machinery, tools, etc. Stop watch, gas analysis, tachometers, electric motors, volt meters, ammeters, endurance machines, dynamometer base plate, Witherbee battery, annealing furnace, engine support, etc., Mathot indicator, Nernst lamp, rotary meter, carbureters, special testing fixtures, etc. C. F. Clarkson, 7 East 42d St., New York City.

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Building the Pierce Great Arrow Car

How Cylinders, Crank Cases and Other Parts Are Machined, Jigs and Fixtures Used and Methods Which Prevail in a Modern Automobile Shop

EDITORIAL CORRESPONDENCE

The location, the layout and the construction of the Pierce-Arrow Motor Car Company's plant in Buffalo, N. Y., all appeal to anyone who admires and appreciates modern advancement in machine-shop buildings and work. Located on the site of the Pan-American exposition, it strikes one by its neatness, its size and above all by the splendid lighting effect obtained in all parts of the works. This is shown to some extent by the lighting of the photographs although they were taken on a stormy day.

One of the first things that impresses one is the neatness and the lack of crowding, although this does not mean that machines are not within speaking distance. While in many departments they are as close as can be comfortably, still there seems to be ample room on every hand.

We are indebted to Henry May, the manager, to George Cooke, the general superintendent, and to Mr. Guider for the information obtained and the assistance and coöperation that made possible the securing of the many interesting photographs.

The Cylinders

The Pierce method of handling cylinders is to first face off the base flange, then drill the six bolt holes for attaching to the crank case and work everything from these holes.

The cylinders are cast in pairs and the base drilling jig is seen in Figs. 1 and 3. The jig is of the open-box type with V-jaws *A*, at each end, operated by a right- and left-hand screw *B*, and acting upon the barrel of the cylinders as can be seen. This locates the holes with the barrel on the unjacketed part and keeps the bore central with the casting. The bushing plate is located by two dowel pins *C C*, Fig. 3. The bushing plate is held firmly in place by the equalizing lever *D* which is a part of the clamping arm *E*, held by the hand nut as shown in both views. The jig is very easily adjusted and when mounted under the Hamilton drill shown, affords an easy and rapid method of drilling the initial holes accurately.

Boring the Cylinders

Next comes the cylinder boring on double-head Beaman & Smith machines as shown in Fig. 2. Here the cylinders are bolted to the fixture shown, held by the corner holes and located by dowel pins in the others so as to keep everything

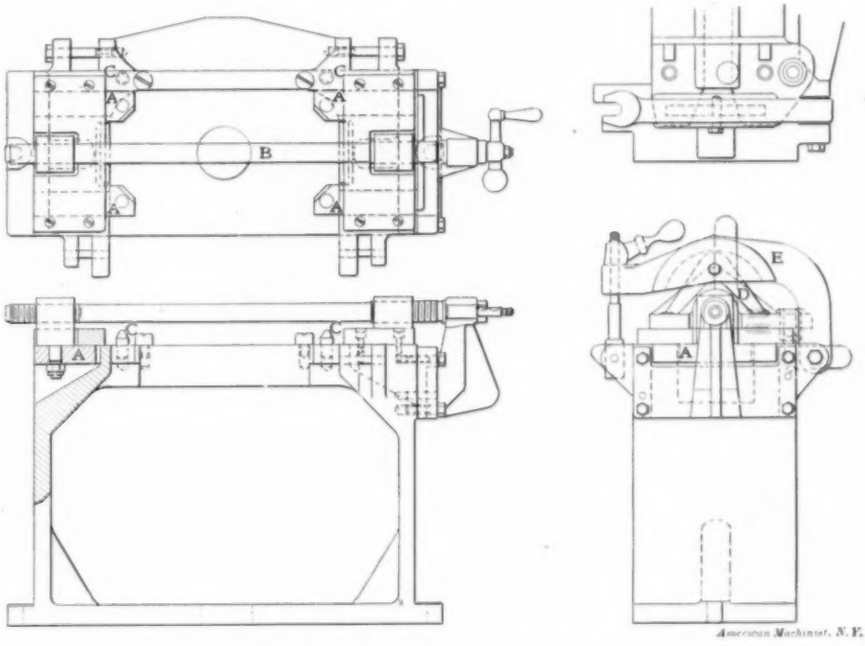


FIG. 3. DETAILS OF CYLINDER BASE DRILLING JIG

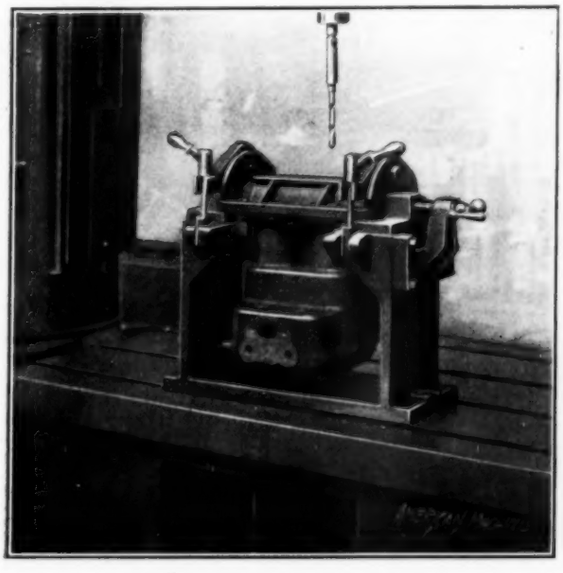


FIG. 1. DRILLING BASE FLANGE

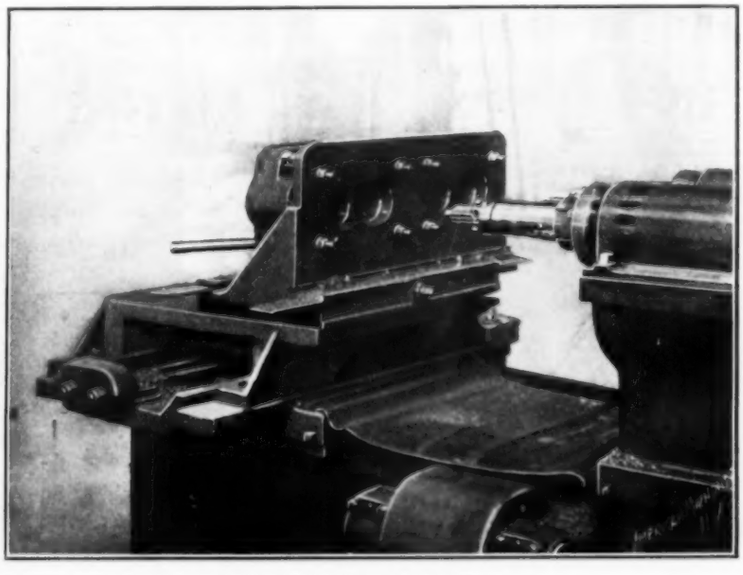


FIG. 2. CYLINDER BORING

in line. Two cylinders are bored at once, the left-hand cylinders in this case, and, after these are bored, the lever at the back moves the whole fixture to the left, coming to a solid stop at the proper point. This locates the other cylinder at the correct distance from the first, accurately, exactly alike every time and without measurement of any kind.

Two sets of boring bars are used, one for roughing, the other for finishing, both being driven by a heavy key across the face of the spindle and bolted to it by four heavy bolts.

Cylinder Drilling Jigs

Figs. 4, 5 and 6 show the jig for drilling the various cylinder holes and is one of the most complete and ingenious drilling jigs we have ever seen. As can be seen from the different illustrations it consists of a pair of end plates connected by four bars, a supporting frame in the center and the base which supports the jig while being used.

The jig is placed on end, the four nuts *D* acting as feet and the cylinder casting lowered into place, the four flange-bolt holes centering the cylinder on the four dowel pins *E E E E*. Then the cover or top plate is put in place and locked, the cylinders clamped in place by the hand screw at the top and it is ready for work.

With the base resting on the drill table, the jig is laid on the rods, rolled up into position so that the index pins *P P P P* come in between the locating pins *L* in the base, and the cylinder is ready to be drilled on one side. Rolling it over to bring the first of the three pins into place, the angular holes *F* or *G* are drilled, then the center pin is engaged and so on with all the rest.

After all the side holes have been drilled and tapped, the jig is stood on end over the bars as in Fig. 5, so that the bars form a support and give an even footing for the jig, the top holes are drilled and tapped and the cylinder is ready for the next operation.

Boring the Valve Chambers

The valve chambers are bored in a Gisholt lathe as shown in Fig. 7. The round base plate carries dowel pins to locate the cylinder and the arch-shaped casting *A* is also bolted to the circular plate, directly in line with the boring tools as this is a guide or bushing for the end of the boring tools. The bar is supported by the regular bridge or rest which is used on the Gisholt and the end goes into the bushing so that there is little chance for any running out of true or of spring to the bar. Then the cylinder is shifted to bring the other valve chamber in line and the work proceeds. A new fixture is under way to index the cylinder around so as to facilitate the handling in this way. The

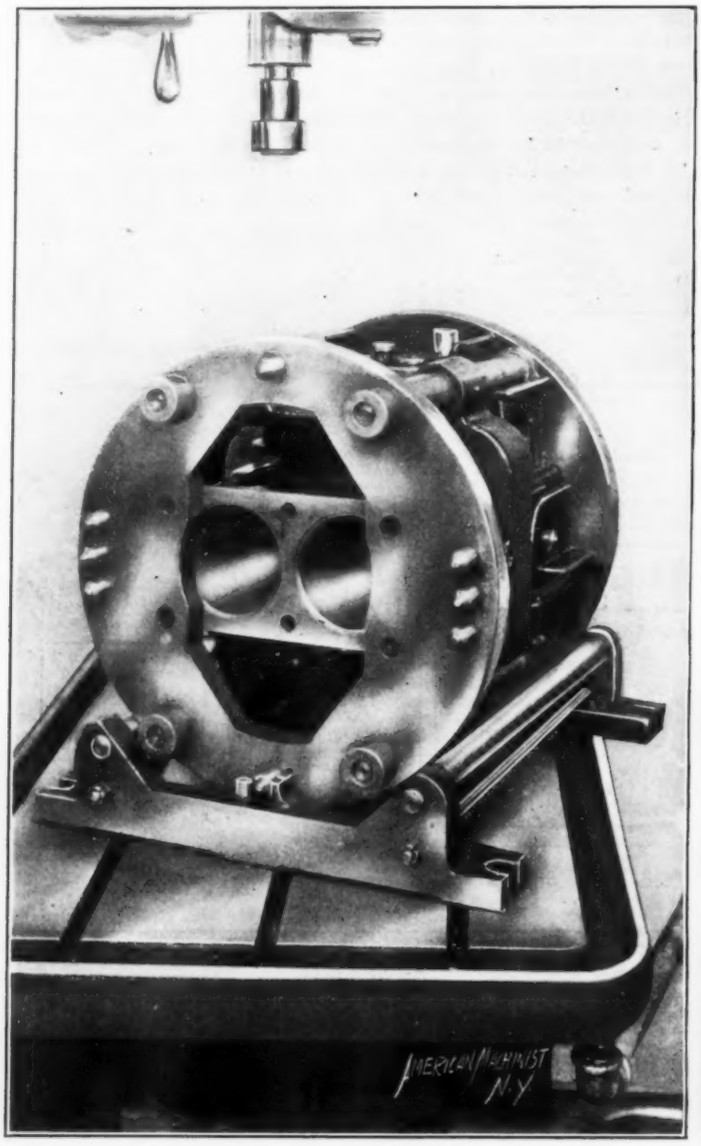


FIG. 4

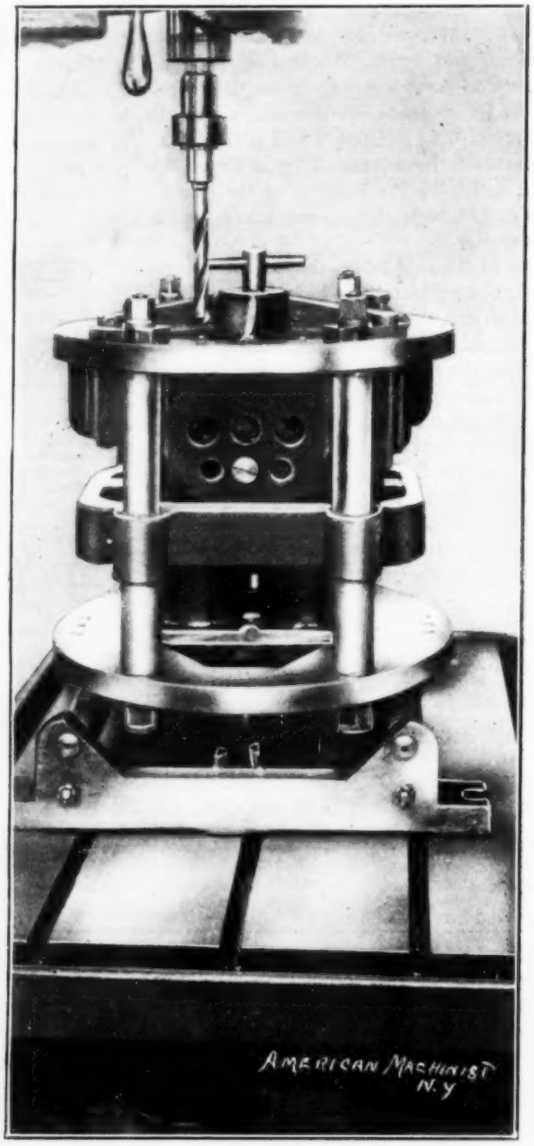


FIG. 5

CYLINDER-DRILLING JIG

counterweights take care of the balancing of the cylinders in the lathe. The facing is looked after by the boring bars but the recessing is done with the hook tool in the tool post while the tapping is done with a geometric collapsing tap.

Then comes the grinding of the bore, and this is done on a Heald cylinder grinder as shown in Fig. 8. The only peculiarity about this process is the support for the cylinder. The base bolt holes serve to center it as before, and stops are provided to insure the cylinders being the right distance apart. To prevent all sag of the cylinder, a tailstock is provided which supports the back end of the cylinder. The exhaust is shown connected to remove all dirt from grinding through the pipe shown.

Handy Inside Micrometer

On top of the cylinder is a very handy measuring instrument to make it easy to take correct measurements. Any mechanic knows how easy it is to get an inside micrometer cramped in a cylinder bore, and this is practically a holder for the micrometer. It consists of a base having parallel edges and a block to hold the inside micrometer at right angles to it. But instead of holding this rigidly, it has a vertical movement in the slot shown and is held only by a pair of springs so that it can be tipped forward when desired to assist in securing a measurement. This combination makes a very handy instrument which is shown in more detail in Fig. 9.

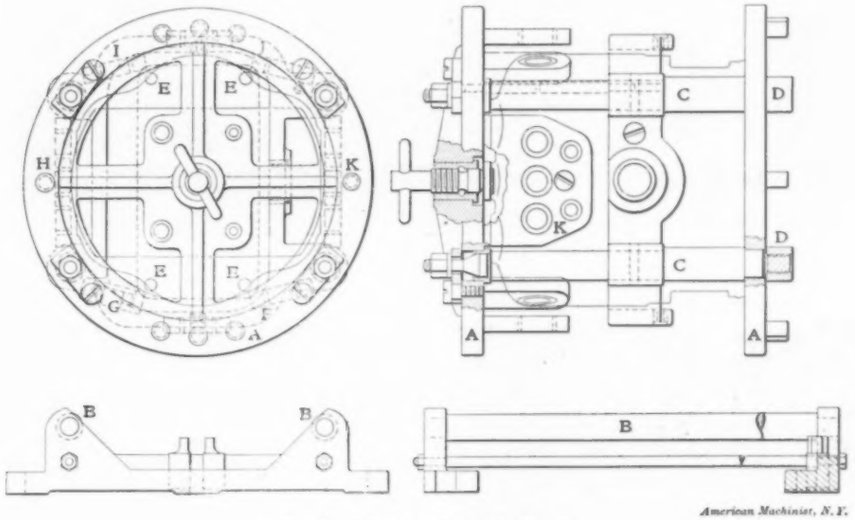


FIG. 6. DETAILS OF DRILLING JIG

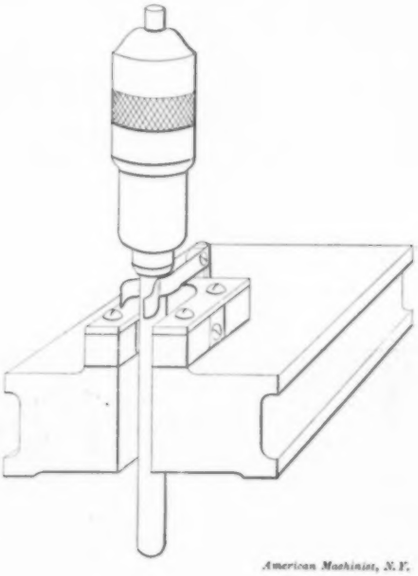


FIG. 9. HANDY INSIDE MICROMETER

The Engine Crank Case

The crank cases begin their journey in a large Becker vertical milling machine which forces off the top and bottom as shown in Fig. 10. After this is done, the piston holes are bored, also on the milling machine, the center distances being located by an index plate on the front of the table.

From here they go to the large Beaman & Smith milling machine shown in Fig. 11. The bearing caps are bolted in place and the whole case bolted to the angle plate, supported in front by the small screw jacks shown. Then the gang of six inserted-tooth cutters gets to work and faces down the sides of the bearings in a very short time, making them all exactly alike.

The next step is the three-spindle boring machine by the same maker, which bores the seven bearings and is used to face the end bearings by facing cutters and stops which locate them from the next bearing. This also bores the cam-shaft bearings on each side at the same time. The boring is done by moving the carriage away from the head so as to keep the bars always in tension. The main bar is supported in the center by the false bearing shown, to prevent any tendency to sag or chatter.

From here the crank cases go to the drills and the jig shown in Fig. 13. The

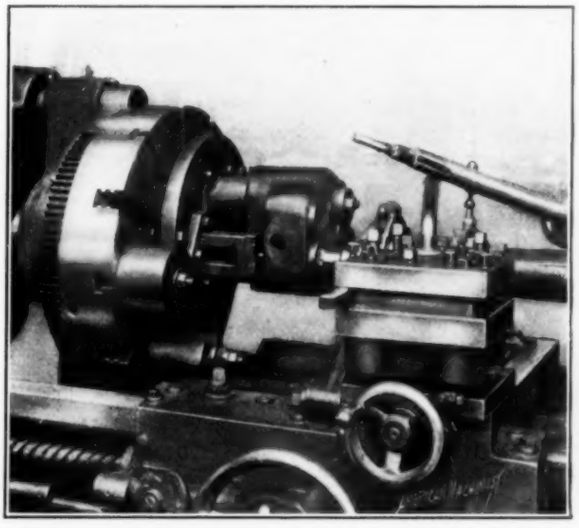


FIG. 7. BORING VALVE CHAMBERS

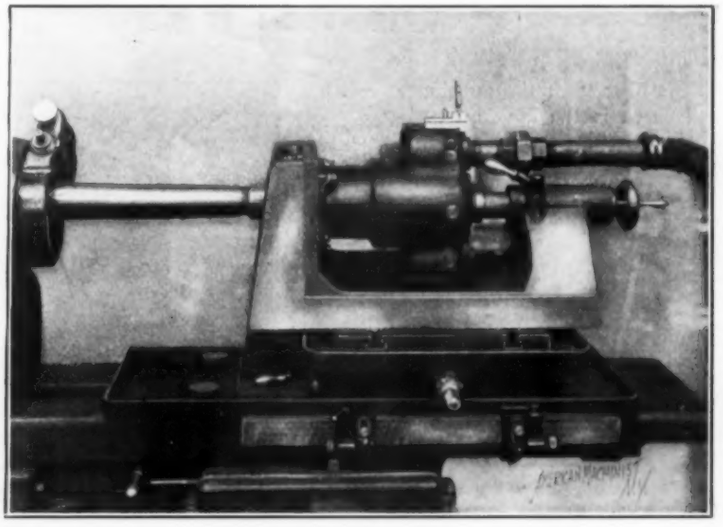


FIG. 8. GRINDER SUPPORT FOR CYLINDERS

case is located by the two large uprights which represent the pistons and fit into the end bores of the case. The top plate is lifted on, the nuts put in place and the crank case is ready to have its numerous holes drilled, both top and bottom, as indicated by the multitude of bushings in both plates. This is a very complete jig in every way.

In order to trim the bosses up neatly and leave everything ship-shape in the Pierce way, they have used a Hisey electric-portable drill in a very ingenious manner. The drill is mounted in the frame shown in Fig. 14, the bottom *L* carrying a pilot which just fits the holes in the bosses. The drill carries a taper reamer offset just enough to give the desired radius and outside of this is a stop pin to prevent the reamer being swung too far either one way or the other. It makes a very handy way of using any portable drill,

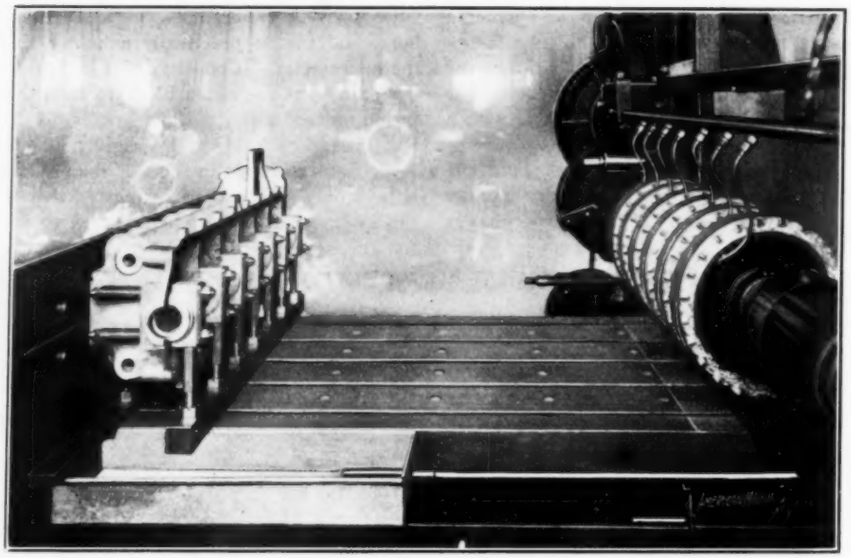


FIG. 11. MILLING SIDES OF CRANK BEARINGS

FIG. 10. MILLING CRANK CASES

and the details of the attachment can be easily seen in the illustration.

Piston Rings

The piston ring is always an interesting proposition, especially in small gas-engine work, and it is particularly so in this case. A Potter & Johnston automatic has been rigged up as in Fig. 15, to turn and bore rings eccentric at the same time. The boring is done in the usual way with the bar in the turret and at the same time the turning tool is moved back and forth to give the desired eccentricity to the ring.

This is accomplished by the steel ring *A*, fastened to the face of the chuck which is turned to the eccentricity desired and acts on the front tool carriage to move it in and out at each revolution.

At the same time, the V-shaped projection *B* on the ring *A*, strikes the piece *C* and forces the arm *D* back, and in so doing forces the small chisel *E* forward to mark the ring at the thin point. This occurs at each revolution and in doing this marks a very distinct line across the face of the ring to show just where the thin point is, as a guide in cutting the rings apart on the milling machine.

As the rings are turned, the cutting-off tools at the back come into play and cut off one at a time, the outer tool being set out the farthest and each of the other tools being a little behind it.

Finishing the Rings

Then the rings are cut in the usual way, are held in arbors to be ground, and also ground on the sides by the small Heald grinders with magnetic chucks, but after all the machine work is done there is still a trifle left for the final fitting and finishing. After being cut in two at the thin side the rings go to the

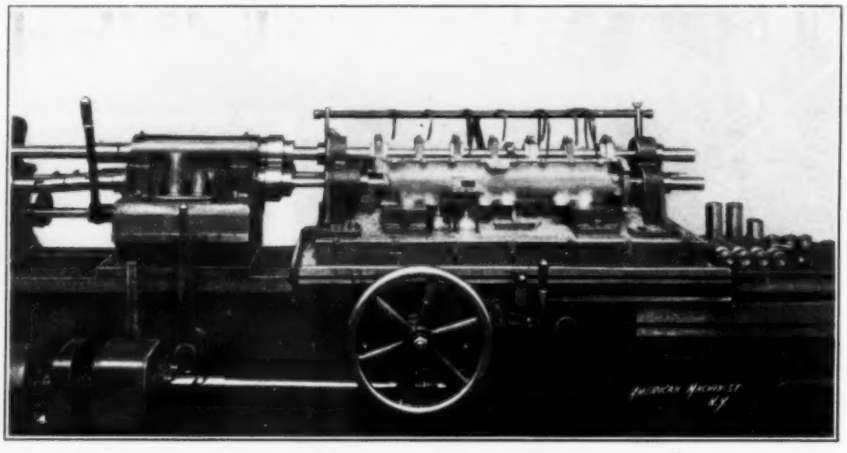


FIG. 12. THREE BARS AT WORK ON CRANK CASE

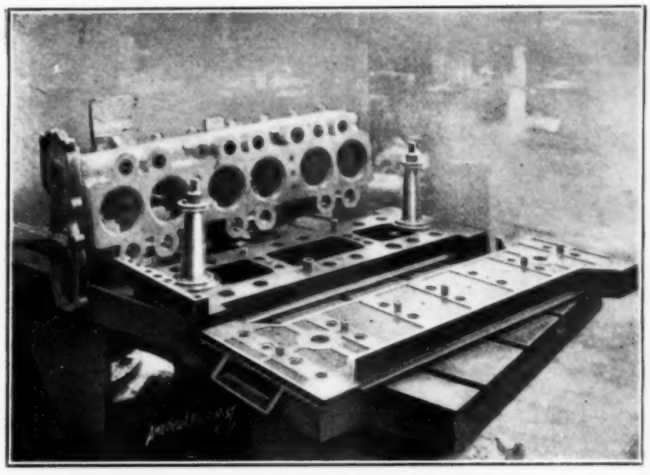


FIG. 13. DRILLING JIG FOR CRANK CASE

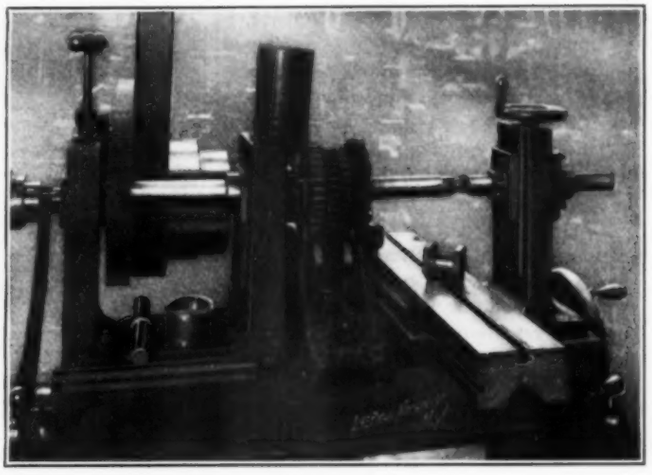


FIG. 20. MILLING FIXTURE FOR STEERING FORK

small Simplex bench filing machine, Fig. 16, which has been fitted with a special ring-holding fixture as shown. The ring is placed in this with the open ends at the top, over a supporting arm, and is held down against it by the lever while the ends are sprung together by the operator. The file goes through the lever and between the two guiding rolls and a few strokes trim up the ends of the ring very nicely.

The fitting of all the piston rings is practically hand work, helped out by a couple of ingenious machines made by Mr. Tertobe, who does most of this fitting with the aid of an assistant.

The final fitting of the ring is done on the machine shown in Fig. 17. Placing a ring *A* on the same machine and clamping by a slight turn of the handle, the file is swung over the ring and a movement of the pilot handles at the left turns the ring and also moves the file back and forth over it. This is accomplished by a rack meshing into the gear just shown behind the piston ring. Then the ring is put in a piston and tried in the cylinder as at *B*, this being repeated until the "feel" is just right.

For dressing off the sides of the ring, the little machine at the right is used. This carries a file in the upper holder, while the ring is clamped in revolving base below. A few turns gives it just the relief needed, similar to drawfiling, and when they are just right, the motion

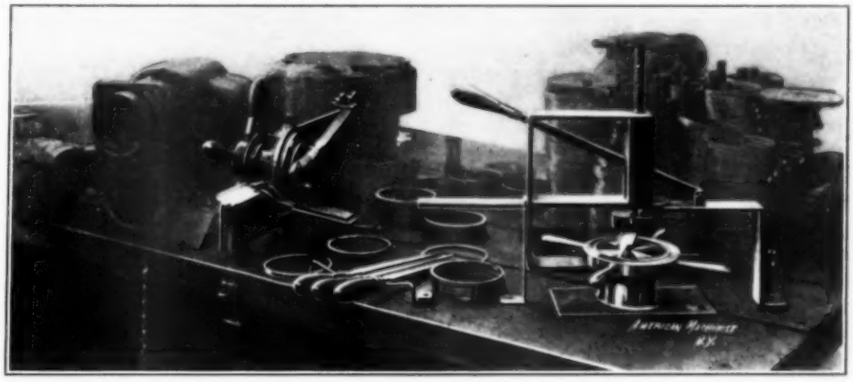


FIG. 17. FILING DEVICE FOR FITTING PISTON RINGS

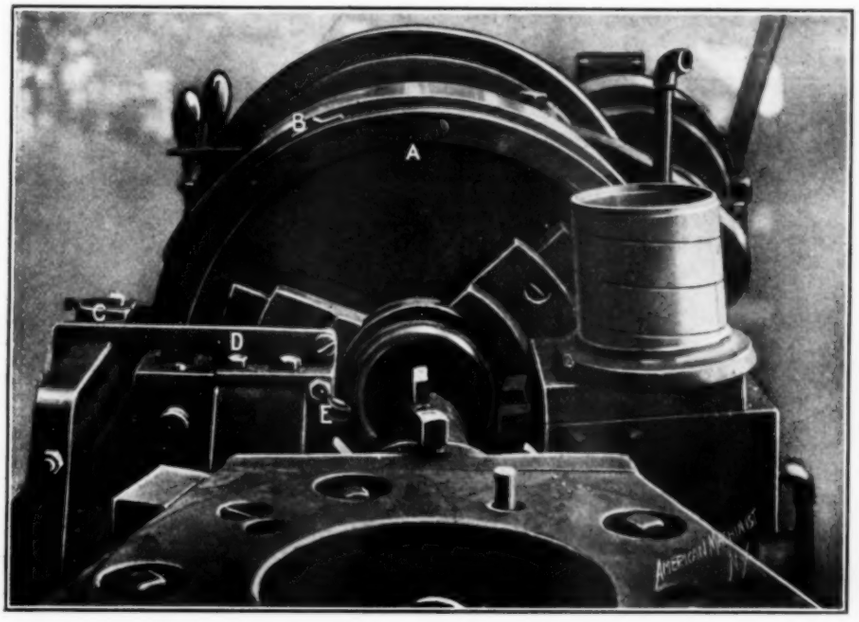


FIG. 15. TURNING ECCENTRIC RINGS

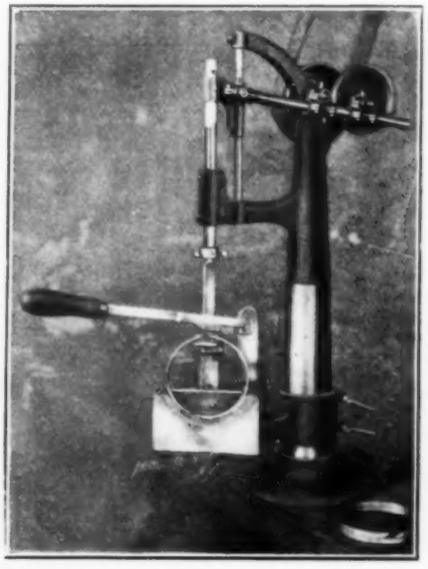


FIG. 16. MACHINE FOR FILING RINGS

is ready for test so far as the piston rings are concerned. For dressing a single point on the rings, the fixed file is not always used, one of the others being picked up for this purpose. The file card is handy for keeping them free from dirt and chips.

The Drilling Department

All the drilling machines are in one long row, as seen in Fig. 18, each set on the concrete foundation which runs the whole length of this department and has a gutter at the back for the return of the lubricant. This is piped to each machine from a main pumping system and returns along the gutter at the back.

One of the heavy Baker machines is shown in Fig. 19, with a front axle in place in a drilling jig, and the size of the chips indicates a healthy appetite on the part of the drill. This makes a good-sized jig, the bushings and bushing plate being transferred from end to end and located by dowels and insuring duplication in the steering center and the tread of the steering wheels.

A Circular Milling Job

One of the many adaptations of the Lincoln miller is shown in Fig. 20 in connection with the milling of the steering fork shown on the table. The sides of this are straddle-milled in the spaces between the cutters while the center cutters mill off the circular portion of the hub of the fork.

To turn the work while being milled the fork is fastened to an arbor, mounted in the casting shown, and carrying on its outer end a segment of a gear shown at *A*. This meshes into the rack fastened to the side of the table, and the regular table feed gives the rotary motion which turns the work and mills the curved side of the hub.

This makes a very ingenious attachment for use on this type of milling machine and one that can be adapted to many varieties of work.

FIG. 18. DRILLING DEPARTMENT

Lathe with Two Heads

The rear axle or driving-gear case is not an easy piece to machine, especially the cross-holes shown in position in Fig. 21. To do this quickly and accurately the second head was put on the Le Blond lathe, that turned it into a double-headed boring or milling machine.

The auxiliary table or plate goes at the top of the carriage and carries the work, as shown, so that the two holes can be drilled accurately in line and the bosses faced or milled off square with the holes. Stops on the bed at the end of the carriage regulate the depth of cut and insure duplication of work. The gear cases are located by dowel pins and held in the same position in each case.

A Cam-milling Fixture

An ingenious cam-milling fixture for cutting the jaws in a three-jawed clutch cam is shown in Fig. 22. The top view shows the barrel of the fixture at the angle of the clutch jaws and it will be seen that the spindle is double, the inner one carry-

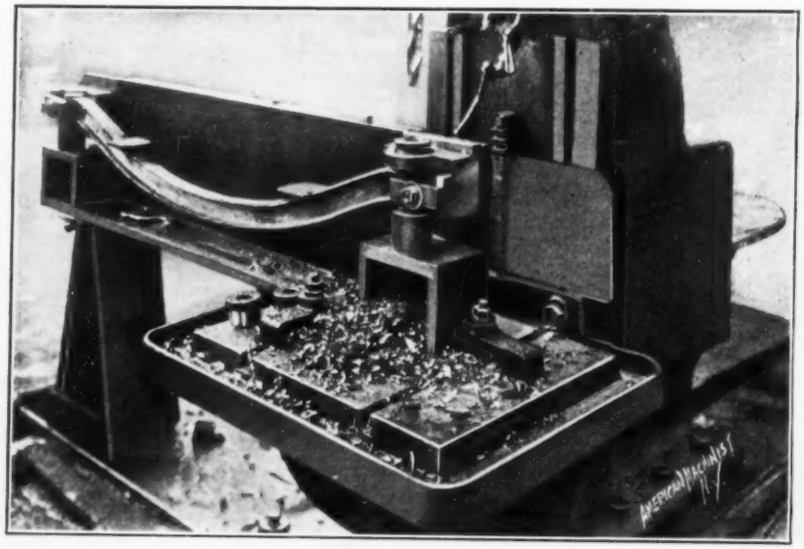


FIG. 19. DRILLING FRONT AXLES

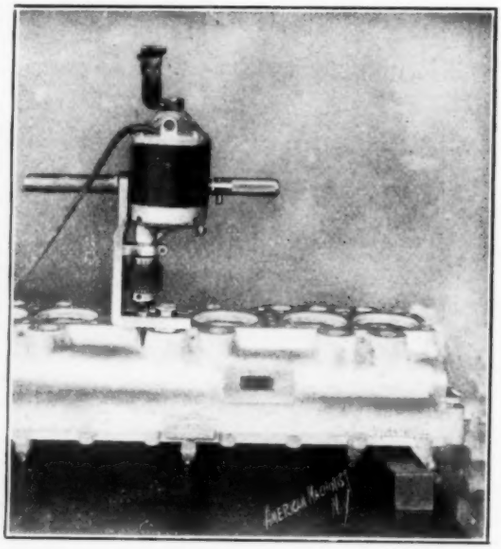


FIG. 14. PORTABLE DRILLING TOOL

ing the work and the outer one having a coarse thread which advances the work against the milling cutter to give the feed and bring the angle of the jaws as they should be. The back end of the outer spindle *B* is also provided with a three-jawed clutch to mesh with *C*, which is free to slide on the inner spindle under control of the cam and the spring. *E* is a fixed stop while *F* and *G* are limiting stops which control the movement of the barrel in either direction by the handle *D*.

Starting with the work in the position shown with reference to the milling cutter, the handle *D* is moved until the pin *F* strikes *E*, when the cut is completed. The handle is then brought back to the starting point, with *G* against *E*, and the downward movement continued until the cam *C* has been turned back one-third of a turn, riding upon the cam *B* until the lips meet and the springs force *C* into the new position. The work being fastened to the inner spindle, has also been turned one-third of a revolution and consequently presents a new face to be cut. This is repeated until all three faces are cut.

An Echo from Another Direction

By W. Osborne

One of the frequent oil country job-shop jobs is drilling pipe so that it will act as a strainer for a pump and prevent pieces large enough to interfere with the valves from passing through. To drill a pipe full of holes and to do it in quick time without breaking drills is not one of the very easiest of jobs, or at least so most of us, as boys, thought.

I visited the shop of a man who supplies the material for large artesian wells and part of it is pipe-drilled and wire-wound for screens. Here pipe is drilled in large quantities. Pipes from 3 inches up to at least 12 inches are used and sometimes over a hundred feet of this screen is used in a well. The holes are all ½ inch in diameter and are about 1¼ to 1½ inches from center to center each way. Three drill presses are kept going. Two of these have three spindles each; the other has one spindle. High-speed drills are used. The question of breakage of drills is solved by the company furnishing one new drill a month to each man, and unless the man can show it defective he furnishes himself any others needed.

All the drilling is piece work and the rate is 4¾ cents per 100 holes. Each man moves his own pipe from hole to hole. It did not seem as though drilling 21 ½-inch holes through, say, 10-inch pipe for 1 cent would be a very desirable job, but I was informed that the pay of these men averaged from month to month from $90 to $120.

The man who ran the press with the single spindle seldom got under $90 per month although the top rate was often exceeded by one of the other men. Wishing to test the accuracy of my information I timed some of the drilling and found a three-spindle drill doing a trifle better than 24 holes a minute on a 10-inch pipe. As this rate figures out better than $6.17 for a day of 9 hours and as these drills run 10 hours some of the time, the amount said to be earned seemed possible. The man who had the drill with the one spindle got the smallest and thinnest pipe to drill. He was changing pipe and I did not have an opportunity to time his speed. This was a Texas job and done in a land too hot, supposedly, for hustling.

Dixie used to tell about his work in the machine shops of South America where the shop consisted of a space in the air with a sun shade over it, and where the means of transportation was the patient burro.

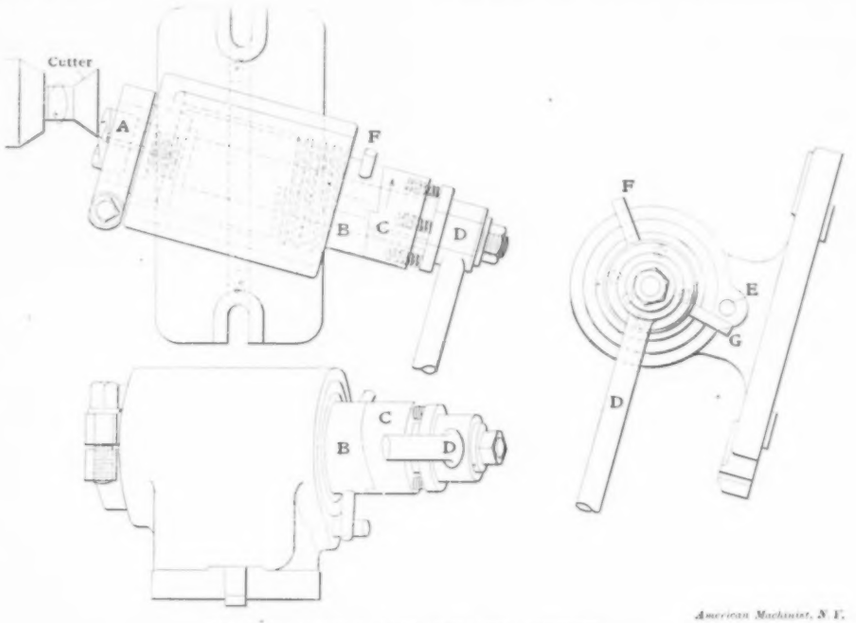


FIG. 22. CLUTCH JAW MILLING FIXTURE

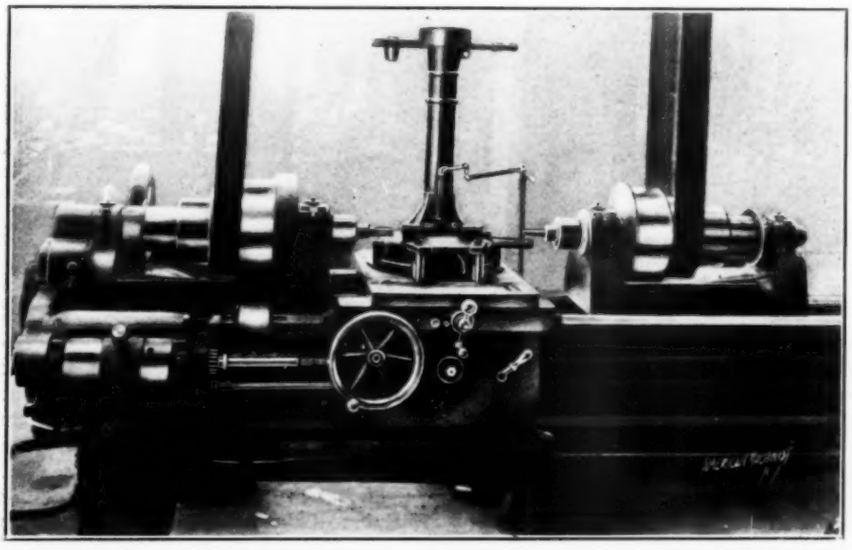


FIG. 21. DOUBLE-HEADED LATHE FOR BORING AND MILLING

A Familiar Sound in Mexico

I have never been that far away from home, but I did get down into the isthmus of Mexico and now I know more about machine shops and machinery. There the houses are made of grass and palm leaves. The roof keeps out the sun and rain. The sides keep out horses and cows and perhaps large-sized dogs. The natives go barefooted and their attire is more for style than for comfort. One thing that puzzled me was the fact that here and there would be a girl or woman very neatly dressed. Being delayed at one point I took a stroll through a native village. On all sides were unfamiliar sights and sounds. Suddenly a familiar sound came to me, but what could make such a sound in this place?

It came from a hut near me. From in front of this hut a number of little brown children had stopped their play to stare at the stranger who was staring at them. Just inside the door on the dirt floor sat a barefooted native woman in décolleté costume. She was so busy sewing on an American sewing machine that she did not pay any attention to me. This was the sound that I had heard and it explained the nice shirt waists and dresses that were so often seen.

On further investigation I found that the Singer sewing machines could be found in the most remote places. Likely Mr. Roosevelt will find them in the jungles of Africa when he gets there.

I had another surprise soon after that. A friend walked me into a power house. It contained five 150-horsepower Diesel engines all directly coupled to three-phase generators. The fuel used is Mexico crude, refined enough to take out the water, and filtered. The fuel consumption is given as 0.65 pound per horsepower-hour. The mechanical engineer in charge of this plant is an Englishman but the men in evidence doing the work are Mexicans.

A Machine Shop at Vera Cruz

In Vera Cruz I found a small machine shop. The lathes were from Massachusetts; the shaper came from Ohio and surely the drill press came from Cincinnati. The workmen all appeared to be natives and most of them were barefooted. The speeds indicated that high-speed steel was not used.

Each man running a machine had a helper attending him. I have been told that should a helper get hurt so as to draw blood the workman that he is assisting is liable to arrest and imprisonment. Think of that in a machine shop with bare arms and bare feet! With such a law few machinists would care to be hustlers. I don't know what would happen if the machinist got hurt.

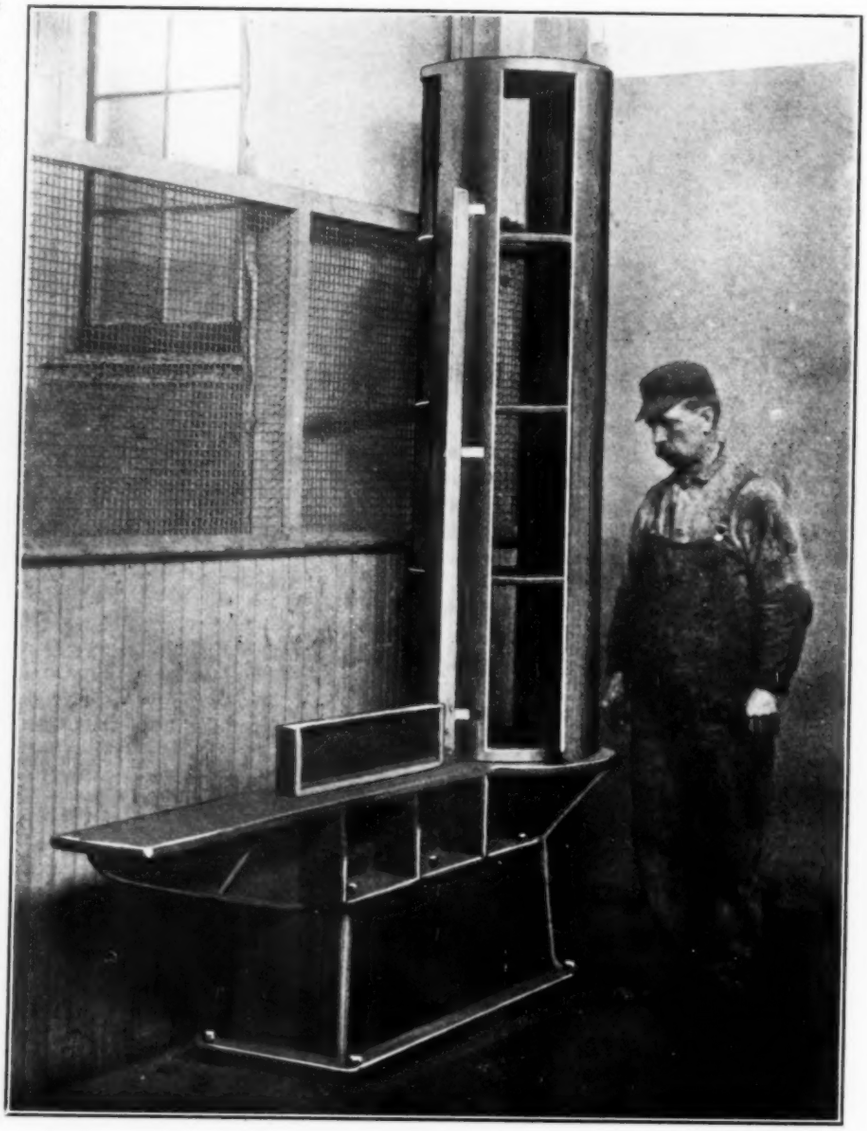
Inability to speak the language has prevented me from gathering up many interesting details which I otherwise might have obtained.

As an instance of the increased attention that is being paid to engineering and technical subjects in the more progressive libraries, a large room, formerly the reading room of the Free Public Library, of Newark, N. J., has recently been converted into the "technical and scientific department." The department is designed to meet the need of the working man and the student and contains about 6000 books and 300 periodicals on scientific, engineering and allied subjects. A file of the United States, English and Canadian reports is also kept, and a large collection of trade catalogs are open for reference. An added feature is the fact that most of the technical books are not for reference only, as might be expected, but may be borrowed for home use.

Fixture for Testing Large Squares

Editorial Correspondence

The halftone illustrates a special fixture built by the Ingersoll Milling Machine Company, Rockford, Ill., for testing large squares used in its shop. These squares are used in testing the uprights on the milling machines built by this company. The uprights have to be square in all directions with the bed and some of the squares used in this work have a blade fully six feet in length. It is important that the squares should be kept in perfect condition, so the special fixture was made of sufficient capacity to test the full length of the blade.



FIXTURE FOR TESTING LARGE SQUARES

As shown in the engraving, the upright on the fixture is a cylindrical casting open at opposite sides, but closed at the ends and well ribbed internally. This cylinder is six feet long and 20 inches in diameter. The cylinder is a well seasoned iron casting, which, in machining, was placed in the lathe, where it was roughed down on the outside and ends, the lower end being relieved from the center out so as to leave an annular bearing surface about 1⅛ inches wide for the column to rest on when placed upright on the base. The casting was then placed on dead centers in the grinder and the cylindrical surface ground true and straight; the end was also ground true while the casting was on dead centers.

The upright cylinder stands on a true surface on the bed of the fixture and the base rests on a concrete foundation. The arrangement has been thoroughly tested for accuracy by revolving the cylinder and testing on four different sides, the error found being so minute as to be negligible.

The method of testing a square with tissue paper between the blade and the column of the fixture is indicated clearly in the illustration, the square shown having a blade length of about five feet.

The Making of Gear Shaper Cutters

A Consideration of the Generation of Curved Surfaces as Applied to the Making of the Formed Cutters for the Fellows Gear Shaper

EDITORIAL CORRESPONDENCE

In order to make clear the difference between teeth cut by formed cutters and those generated by a planing cutter or one which does not cut a tooth exactly the same shape as itself, the Fellows Gear Shaper Company, Springfield, Vt., have prepared some very interesting illustrations to be used in a booklet for general distribution. These are extremely interesting, particularly the diagrams of their cutter-generating machine and the types of generating cutters which are used for special work.

Beginning with the generation of a plane surface by a planer tool and the generation of a cylinder by the lathe tool, it leads to the forming of a flat surface by a broad flat tool and the forming of a cylinder by a milling cutter which has the proper curvature, both shown in Fig. 1. The errors in this case would be of two kinds, first that due to the inaccuracy of the cutter and second, that due to the setting.

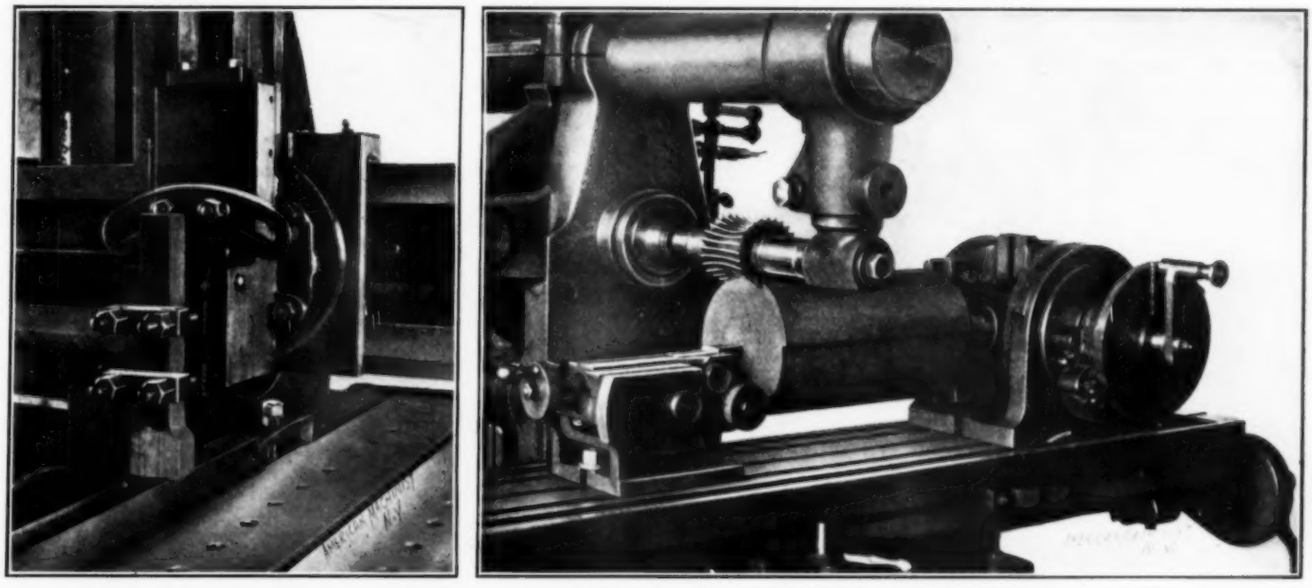


FIG. 1. FORMING FLAT AND CURVED SURFACES

In the gear shaper the tooth is generated by a tool or cutter having in itself the form of a gear tooth, moved in unison with the gear blank, producing a conjugate tooth. This tool may have the form of a rack tooth, its motion with the blank being one of a rack and pinion, or it may have the form of a gear tooth, rolling with its blank, like two gears in mesh. The former method is used in generating the gear-shaper cutter, using a grinding wheel as the generator; the latter the method by which the cutter is used to generate the gear tooth.

The teeth of these cutters are ground to the correct involute curve by an interesting, yet very simple generation of this curve by as simple a method as the case of the planer generating a flat or plane surface with the single point planer tool. This is largely due to the fact that the form of the theoretical involute rack, from which the tooth is developed, is a straight line, so that the generating surface is a plane. It is also similar to the work of a planer in generating a plane surface as it simply requires giving the work, the cutter in this case, a motion past the generating face of the grinding wheel, this motion being in accordance with a mathematical law as described in the definition already quoted.

The Machines Used

The principle of the special machine by which this is accomplished is shown in outline in Figs. 2 and 3. In Fig. 2, *A* and *B* represent a rack and pinion, *C* a gear tooth and *D* a grinding wheel. The generating face of this grinding wheel is located exactly in a plane cutting through one face of one rack tooth and coinciding with it. If the pinion be given a rolling motion with the rack, the action of the tooth *E* on rack tooth *F* will be exactly duplicated by that of the tooth *C* on the generating face of the rotating grinding wheel *D*.

If the teeth of the rack and pinion are perfect, or if their motion be a perfect rolling one, the resultant form of the tooth *C* will be a theoretically correct involute curve.

In actual practice the rack and pinion are not employed but instead, two metal tapes are used, one end of each being attached to a cylinder which represents the pitch cylinder of their cutter and the other ends to a bar which represents the pitch surface of the rack as in Fig. 3. This eliminates the errors that might creep in from slightly imperfect teeth in either rack or pinion, either from design or wear, and gives a perfect rolling motion. In order to maintain this extreme accuracy these metal tapes are changed at regular periods, new ones being substituted in each case.

The teeth of the cutter blank are roughed out before hardening to approximately the correct form, leaving a sufficient amount of metal for the final grinding after hardening. In this grinding operation each tooth of the cutter is successively rolled past the grinding wheel as already described, grinding the tooth into a true involute curve. The indexing device is located between the cutter and the rolling mechanism, being accomplished by a very accurate worm wheel.

After grinding one tooth of the cutter, the face of the grinding wheel is trued by a diamond located in the theoretical central plane of the machine as referred

to in Fig. 2. This grinding and truing of the wheel is repeated with each tooth until the cutter is completed. In the final finish of the tooth curve the effect of the wear of the grinding wheel is eliminated by taking a number of light cuts without feeding the cutter to the wheel, which is trued up between each rotation of the cutter.

Sharpening without Change of Form

Some seem to have obtained the idea that the gear-shaper cutters are bevel gears and, having this idea, they are naturally troubled at the thought of sharpening without changing their form. Sharpening is done by grinding on the face but the correct shape is maintained as long as the cutter lasts. If the clearance was obtained by making it in the form of a bevel gear, the pitch of the cutter would decrease as it was ground back, changing the form of tooth that would be generated. The cutter is generated upon a cylinder instead of a cone and clearance is obtained by making one side of the tooth a right- and the other a left-hand spiral, the angle with the axis of the cutter being sufficient.

The four gears shown have the same diameter of base circle, and the tooth form of each gear is a portion of the involute curve, each gear using a different part of the same curve. Any two of these gears, or any size of gear between the two extremes, will mesh correctly together and with a standard gear. This is not abstract theory, but concrete practice.

A simple experiment of varying the center distance of a pair of involute gears will demonstrate this. Up to the point where the shortened tooth contact affects the continuity of action, the teeth mesh together correctly. If, on the other hand, the tooth be lengthened by extending the involute curve, the centers may be varied until the points of the teeth become sharp.

It is obvious that if the three gears of Fig. 4 mesh correctly together and with a standard gear, any one of these might be used as a cutter to generate the standard gear. The fundamental principle upon which this is based, is the fact that each gear shown has the same base circle, or circle upon which the teeth are generated. If. therefore, the cutter be so designed that all sections are generated upon the same size of base circle, or in other words, upon a cylinder, it is not necessary that we use precisely the same portion of the involute curve as that of the tooth to be cut. The face of the cutter might have the form of one gear, and the back of another gear 1; and the different portions of the cutter brought into use by successive grindings would produce one and the same form of gear tooth.

Relieving the Cutter.

At *B*, Fig. 4, is a cylinder upon which two intersecting spiral cuts have been taken by a milling cutter. The angle of these cuts is very slight, the 4-inch cylinder making about one turn in 30 feet of travel of the cutter. One of these cuts turns to the right and the other to the left. Near the intersection there will be a section of the tooth, which will be of the same thickness as the standard gear tooth. For convenience in showing this the cylinder is made in three pieces, so that this portion may be removed. The tooth of the removable portion represents one tooth of the gear-shaper cutter.

It is obvious that if the outer diameter of the cutter were made cylindrical, as in the piece shown, the teeth cut by the cut-

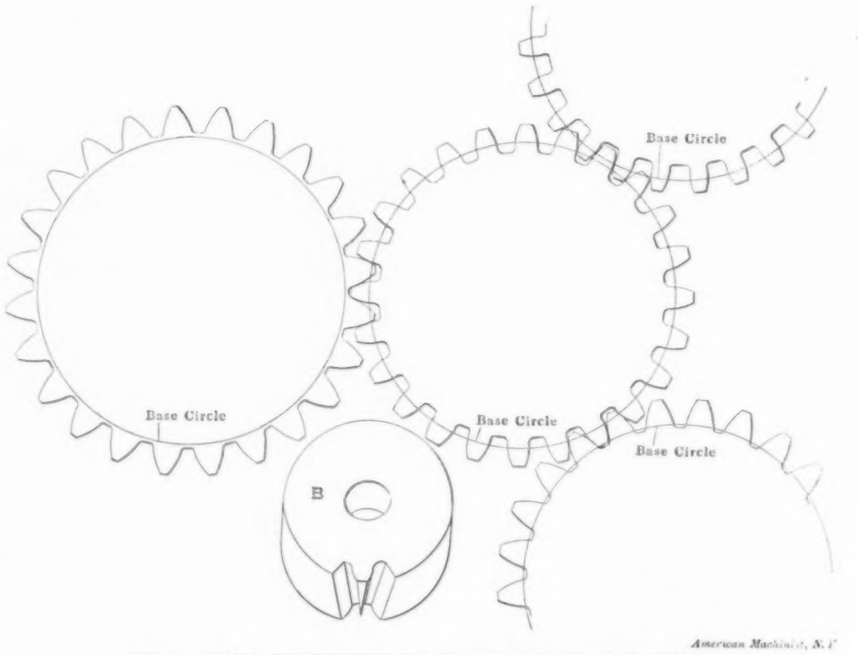


FIG. 4. GEARS OF DIFFERENT DIAMETERS AND RELIEVED CUTTER

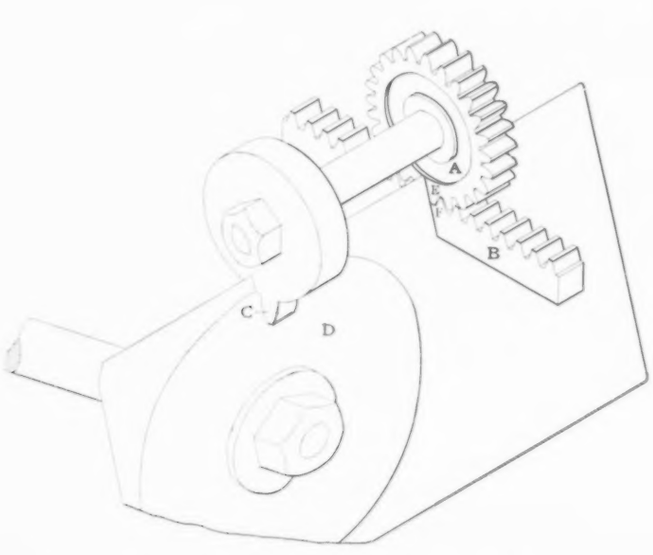


FIG. 2. GENERATING WITH RACK AND PINION

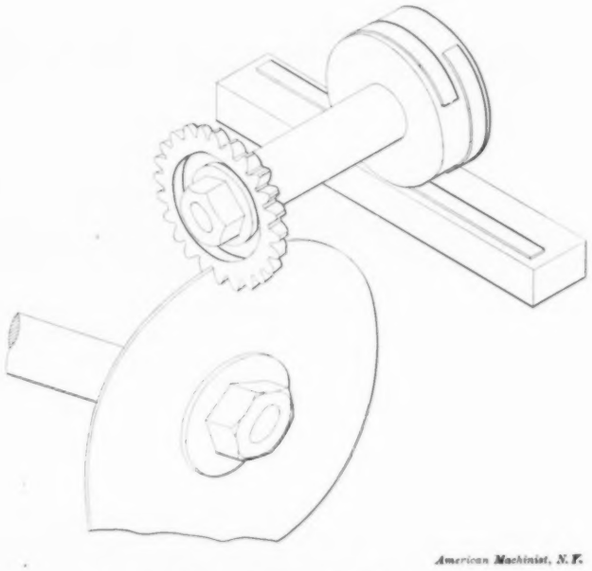


FIG. 3. GENERATING BY USE OF TAPES

ter, after sharpening; would be thicker than those produced by a new cutter. This is very simply obviated by beveling the outer ends of the cutter teeth an amount sufficient to keep a fixed ratio between the thickness and the length.

The facts are that in designing this cutter advantage was taken of the flexibility of the involute system. The involute curve has no fixed pitch point, while in the epicycloidal or double curve system the point of the junction of the two curves must be located exactly on the pitch line of the gear. This gives the advantage to the involute curve as, being a single curve, there is no fixed pitch point so that the center distance of a pair of gears may be varied without affecting the theoretical action.

Action of Involute Gears

This may easily be tested experimentally by varying the center distance of a pair of involute gears. Up to the point where the shortened tooth contact affects the continuity of action, the teeth work together correctly. If on the other hand, the tooth be lengthened by extending the involute curve, the centers may be continued until the points of the teeth become sharp. This is shown in Fig. 4.

The outer diameter of the cutter is also beveled a sufficient amount to give the required thickness of tooth at all points so that in the different stages of wear of the cutter different parts of the same involute curve are used. But this curve being generated upon the cylinder, the form of tooth produced by its different parts does not change. The tooth generated by a worn-out cutter is exactly the same as when the cutter was new.

To illustrate this still further, Fig. 5 shows a gear which represents an exaggerated gear-shaper cutter. In this the teeth of the gear are extended in both directions to about six times the thickness of the gear cutter used. This gear is really made in three pieces, the middle portion representing the part of this gear which was actually used as a cutter.

This gear, as well as the cutters, is cut on a special gear shaper having its work spindle inclined to the travel of the cutter at an angle of five degrees. It is generated by a cutter which has the form of a theoretical gear so that each part of this gear is conjugate to the cutter, and any part must have a correct action with the cutter or a gear. This being true, any

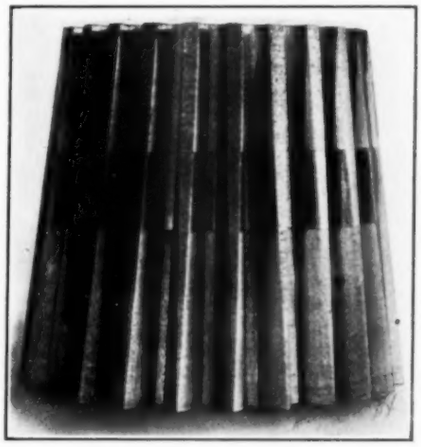


FIG. 5. ABNORMAL SPUR BEVEL GEAR

part of this gear might be used as a cutter and in turn generate a correct gear.

To those whose experience has been only with the formed milling cutters, it is difficult to realize that the form of a generating gear cutter is not necessarily a fixed one. In the case of the formed mill, it duplicates more or less exactly a reverse of its own form, and but one form of mill can be used for a given form of gear tooth. With the generating cutter, any form between the extremes shown in Fig. 5 will generate the same involute curve. The variations in diameter of the various sections of the gear-shaper cutter are, however, but slight, being less than 2 per cent.

Cutting a Square Hole

When the idea of generated instead of formed teeth is once fixed in the mind, there will be no difficulty in understanding it. As a help along this line, the cutter and gear in Fig. 6 will be of service. Here the three-cornered cutter generates a square hole in the gear shown, by being geared at a ratio of 4 to 3 with the gear to be squared. That is, while the gear is turned 3 times the cutter turns 4, and planes out the hole as shown.

Fig. 7 shows how the cutter is generated so as to be exactly right for the work. After hardening it was put in place in the gear shaper ram and the small portable electric grinder shown is mounted on the table. Then both the table and the ram are turned, the table making 3 times to 4 of the ram and the sides are ground to just the right curve.

Grinding the Cutters

The machines used for grinding these cutters are a good example of the possibilities of development of the grinding process. They are the result of ten years of experiment and experience. This has resulted in several types of machines for producing this work, those now employed being the third generation as counted from the original machine used in doing the experimental work for the gear-shaper cutters. In fact this process is made possible only by the simplicity of the generating scheme and the fact that we are originating from plane surfaces only and at all times instead of with curved or specially formed surfaces.

In all mechanical work there are but two surfaces that can be tested and proved to be correct or if in error, the exact amount of the error indicated. These surfaces are the plane and the cylinder,

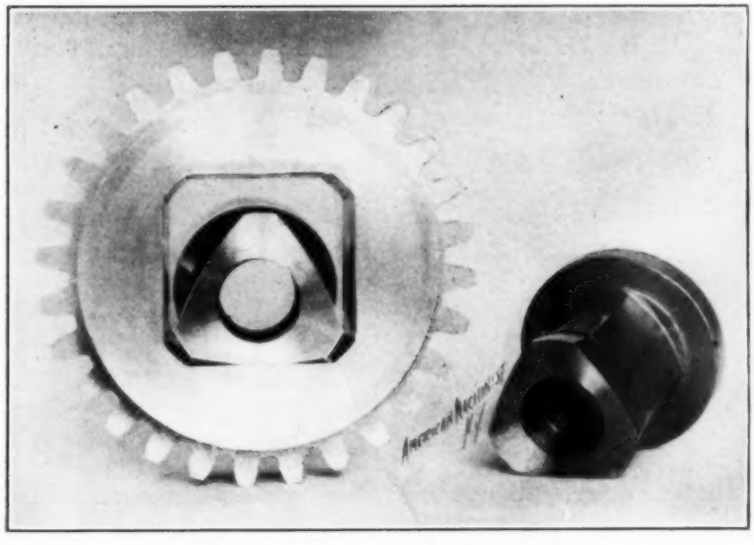


FIG. 6. GENERATING A SQUARE HOLE

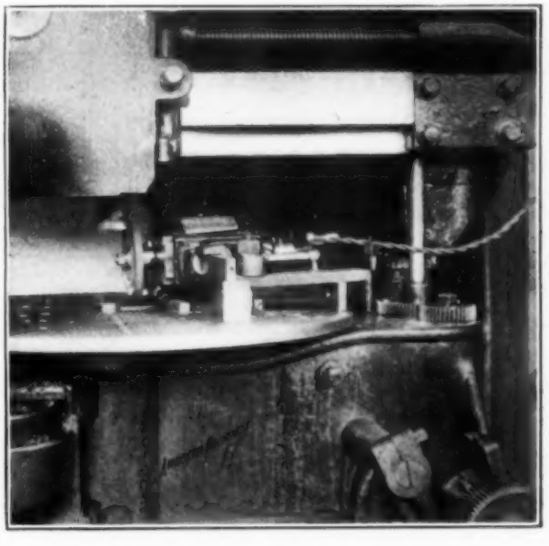


FIG. 7. GENERATING SQUARE HOLE CUTTER

both of which are generated. Forms more complex than these are seldom used and only in rare cases where the degree of accuracy necessary compares with that of the gear cutter.

After the last grinding the cutters are inspected by means of special testing fixtures with multiplying levers and an accurate indicator which gives one ten-thousandth of an inch as the unit of measurement. These fixtures are so designed as to measure the thickness of each space and each tooth. Each cutter passes two inspections before being finally passed as being perfect.

Taking Care of Interference

Cutters for an interchangeable set of gears should be so designed that any gear of the set will run with a pinion of 12

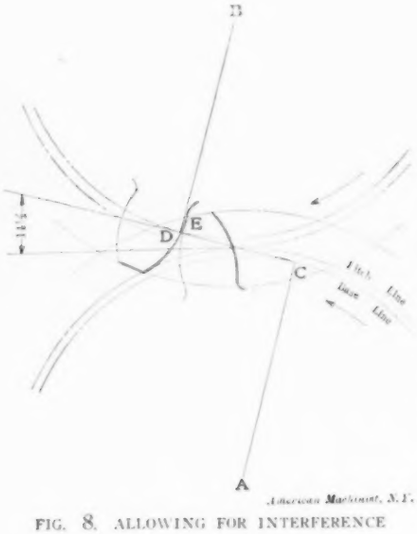


FIG. 8. ALLOWING FOR INTERFERENCE

teeth. It is, however, a fact that, if such a set of gears of 14½ degrees angle of standard length was made, having teeth of theoretically correct involute curves, they would not run together. The teeth must be "corrected" for this interference, that is to say, in order that a gear of 60 teeth may run with a pinion of 12 teeth, its involute curve must be changed so that when this gear is run with a pinion of 30 teeth, the amount of bearing surface will be reduced.

It is often asked how, if the gear-shaper cutter generates a theoretically correct involute curve, it can compensate for this interference. A little elementary gearology will explain this very clearly. In Fig. 8 the line *C D* is the line of action, or the line upon which contact between the teeth of the two gears takes place. This line is drawn at a right angle to the face of the rack tooth, intersecting the two pitch lines at their point of tangency, and as this is a gear with a 14½-degree pressure angle, has an inclination of 14½ degrees with the horizontal. Lines *A C* and *B D*, drawn perpendicular to the line of action, denote the limit of action.

With a pair of gears rotating in the directions of the arrows, the theoretical action begins at *C* and ends at *D*. If contact between the teeth before and beyond these points could be entirely eliminated, the results would be better, but this is impossible. If a pair of pinions of 12 teeth be rolled together, there is no actual interference of the point of the tooth *D E*.

The action, however, is a rubbing one, the point *D* of one tooth rubbing over most of the curve of *D E*. This rubbing action takes place between the pinion of 12 teeth and gears of all numbers of teeth up to about 40. At this point the actual interference begins and from 40 teeth to the rack, the point of the gear tooth must be relieved.

The form of the theoretical rack is that of a straight line. However, in practice more than one-half of the addendum must be sacrificed for interference.

The relief of the gear tooth for this interference is, in the case of gear-shaper gears, very simply obtained. In the theoretical gear the flank of the tooth below the base line is radial. The form of the curve of the gear-shaper cutter is, down to the base line, a theoretical involute. However, in grinding this cutter tooth, the rolling action before explained is stopped before the position of the face of the generating emery wheel is radial with the center of the cutter. This has the effect of leaving metal on the flank of the cutter tooth, below the involute curve. The amount varies with different pitches and at most is very slight. The metal, which it is necessary to remove from the point to the gear tooth, is thus taken off by the portion of the cutter flank which is never used for finishing the gear tooth.

This scheme automatically regulates itself to a nicety, because the amount of metal removed increases as the diameter of the gear increases. The correcting action begins at about 40 teeth and is greatest in the case of the rack. It has the advantage of removing no more metal from the gear tooth than is absolutely necessary, as the process of grinding the cutter is such that the angle of the flank can be very accurately duplicated.

Jigs and Fixtures for Connecting Rod Work

By A. G. Robb*

Figs. 1 and 2 show a lathe fixture for boring connecting-rod brasses. Fig. 1 shows the fixture before the work is put in position. It will be noted that the fixture is arranged to correspond with the T-end of the connecting rod. Fig. 2 shows the work clamped to the fixture ready for boring. The body of the fixture is made with a guide which drops into a recess in the face plate which centers it, and the fixture itself properly locates the brasses with relation to the bolt holes and

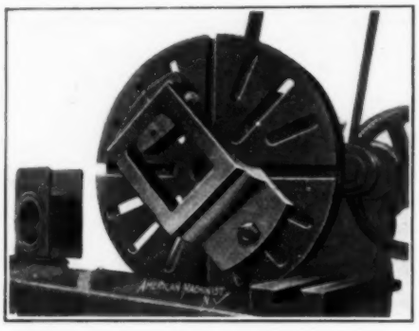


FIG. 3. FIXTURE FOR BORING CONNECTING-ROD BRASSES (CROSSHEAD END)

to the face of the joint on the T-end of the connecting rod and so insures the work being bored parallel with its rod seat.

Fig. 3 shows a fixture for boring connecting-rod brasses for crosshead end. This fixture is provided with dowel pins which engage holes in the face plate to insure quick setting. It is a facsimile of

*Superintendent, Robb Engineering Company, Ltd.

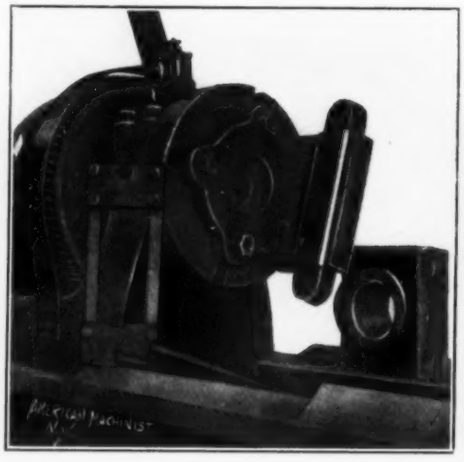


FIG. 1

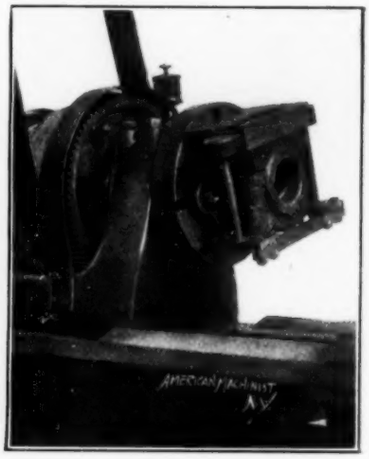


FIG. 2

FIXTURE FOR BORING CONNECTING-ROD BRASSES

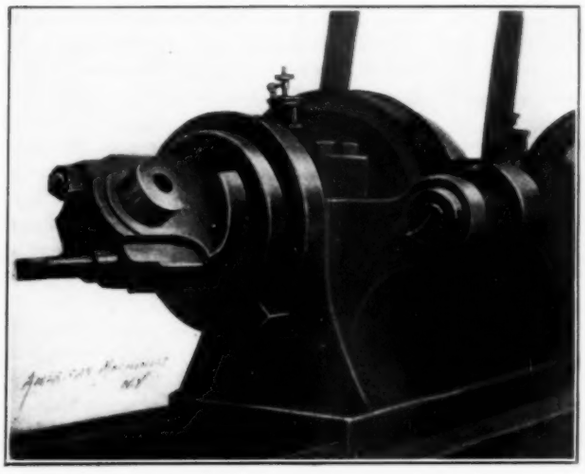


FIG. 4

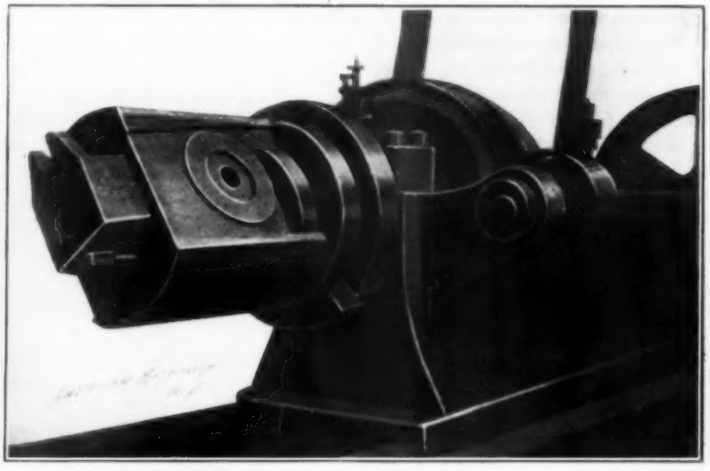


FIG. 5

FIXTURE FOR MACHINING CROSSHEADS

the connecting-rod end itself and is provided with a wedge for setting up the brasses the same as if they were clamped in the connecting rod. The device brings the brasses into proper alinement for boring, and as will be seen the work can be placed in position and removed with very little loss of time between operations.

The fixture in Figs. 4 and 5 is for machining crossheads. It is used for turning off the shoes and boring and threading the hole for the piston rod. This fixture screws into the face plate and takes a bearing on the flat surface as well. The pin shown in Fig. 4 is a duplicate of the regular crosshead pin which is to be used in the crosshead afterward. The crosshead pin is driven in at its taper fit and the cap shown is clamped up, thereby bringing the crosshead into proper alinement. The crosshead shoes are steadied near the face plate by set screws bearing on the inside, but not shown in the illustrations.

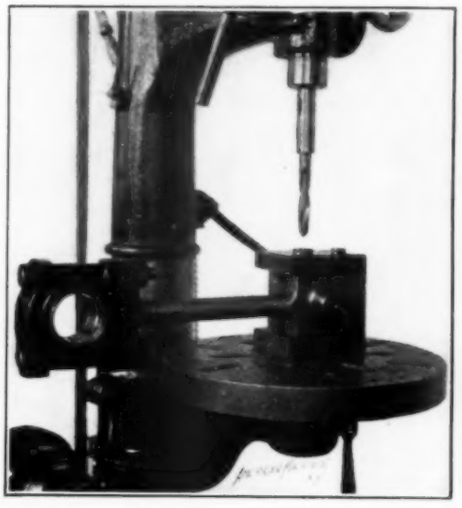


FIG. 8. JIG FOR DRILLING BOLT HOLES IN CONNECTING RODS

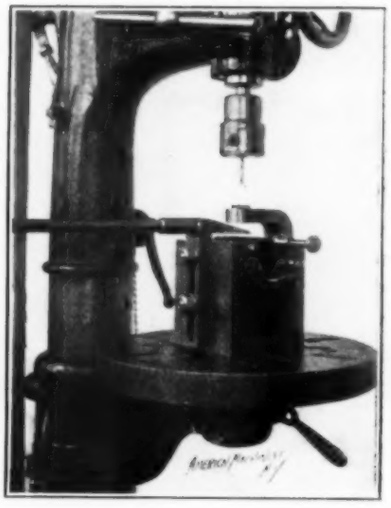


FIG. 9. JIG FOR DRILLING HOLES IN BUSHINGS

FIG. 6

FIG. 7

TRAMMING CONNECTING-ROD BRASSES

In Figs. 6 and 7 is shown the method of tramming connecting-rod brasses. After they have been bored they are scraped until the mandrels are brought perfectly true both for parallelism and for alinement in respect to wind. The tram for the latter test is shown in use in Fig. 7. For both operations standard mandrels are inserted, the connecting-rod brasses clamped to hold them firmly, and the trams brought to bear on the mandrels. In Fig. 7 the tram for wind depends on the flat surface in contact with one mandrel and bears on a set-screw point somewhere about the center of the rod. The outer point of the tram is then applied alternately to each end of the other mandrel. In Fig. 6 the tram rides on one mandrel and the testing point is brought into contact with the other mandrel. The two ends are in this way trammed for parallelism. The mandrels are red-leaded while in use and if the workman finds the brasses to be out of line the bolts are slackened and the mandrels rolled back and forth a few times to mark the babbitt lining of the brasses. He then takes out the mandrels and hand scrapes the bearings with a view to swinging the mandrels in the proper direction to bring them into alinement. He repeats these operations until the trams show the brasses to be correct.

Fig. 8 shows a drill jig used in drilling the wedge and bolt holes at the crosshead end of a connecting rod. Fig. 9 is a jig for drilling oil holes in bushes. The lever at the left side is used for holding the bush in its seat while the drilling is being done and is simply held up by the hand. The screw shown at the right-hand side is an adjustable stop for locating the work lengthwise. The overhanging arm above the work contains a hardened bushing which locates the drill and brings it central with the V which supports the bush to be drilled.

The jig in Fig. 10 is for drilling steady pin holes in the wristplate links of Corliss valve gear. The jig is arranged with a plug at the inside which receives the link and centers it while the drilling is being done. On the right-hand side is shown a link with the steady pin holes drilled. Fig. 11 shows a jig for drilling the pivot used in engine eccentric straps. The principle of this jig is similar to that in Fig. 9. It is used for drilling a hole crosswise through a cylindrical piece of steel like that shown on the drill-press table.

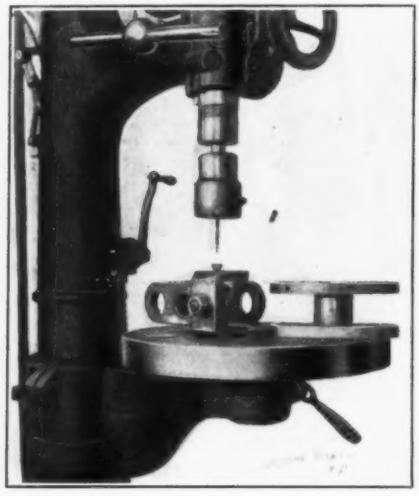


FIG. 10. JIG FOR DRILLING WRIST PLATE LINKS

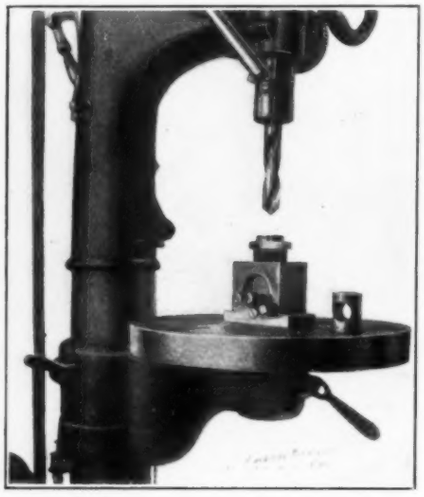


FIG. 11. JIG FOR DRILLING CROSSWISE HOLES IN PIVOTS

Non-Explosive Gasolene Tanks

Tanks and cans of gasolene placed in the middle of a hot fire and the pouring of burning streams of gasolene from one can to another formed the rather startling features of a series of tests made on Friday, March 26, in New York City, in the presence of the Municipal Explosion Commission, representatives of the Fire Department and of the U. S. Navy Department.

Ever since gasolene has been in extensive use, the idea uppermost in the mind of the public has been that this substance is of a highly explosive character, and that the greatest caution should be used to keep it at a great distance from any flame, which it was understood would precipitate an immediate explosion. The tanks and cans tested were manufactured by the McNutt Non-Explosive Manufacturing Company, of New York City, and the results of these tests would seem to show that gasolene when contained in a certain kind of tank is rather a difficult thing to explode after all.

The Davy Principle

The idea involved in the construction of these nonexplosive tanks is that of the well known Davy safety lamp, which has long been in use in coal mines. As is reasonably well known, the Davy safety lamp derives its safety feature from the fact that its flame is surrounded by a very fine wire gauze, the peculiarity of which is that flame will not be transmitted through it.

Fig. 1 is a diagram of one of the cans tested showing its general construction. The mouth of the can is covered by a fine wire gauze, this gauze taking the shape of a cylindrical chamber, so as to give a greater number of holes through the gauze and thus allow the gasolene liquid to pass into or out of the can when desired. Above the cylindrical gauze chamber is a screw cap. In the center of this screw cap is a round metal plug, which is soldered into the main cap by a soft solder. The action of these parts may be described as follows: Suppose that the tank or can is three-quarters full of gasolene liquid, the top part of the can will,

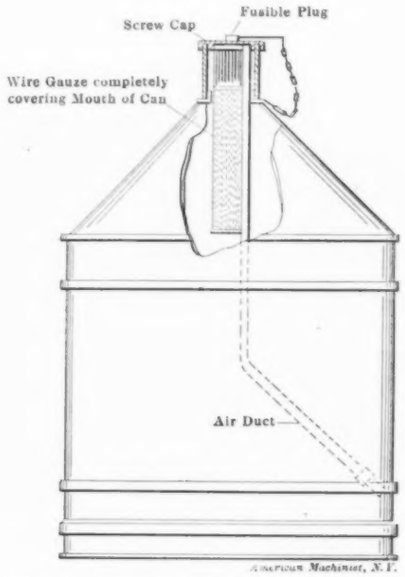


FIG. 1. MCNUTT NON-EXPLOSIVE GASOLENE CAN

of course contain a mixture of gasolene vapor and air, which in all probability is of such proportions as to give a violent explosion in case of the approach of flame. Now, suppose that with the cap screwed down in place the whole can containing gasolene should be surrounded by fire, or placed directly in the fire. The can itself is constructed without solder, so that it will not melt, and moreover, the liquid gasolene within it will prevent it from getting so hot that the steel shell would melt. The warming of the gasolene will, of course, tend to vaporize it and cause it to throw out more gas, increasing the pressure within the can. While this is going on the can itself is becoming hotter and hotter, and before long its temperature will reach 350 degrees Fahrenheit, at which point the fusible plug in the top will melt out. The pressure within the can is then relieved by blowing out through the wire gauze and the opening in the top left by the fusible plug.

As soon as the inflammable mixture of gasolene vapor and air strikes the outside atmosphere, which we suppose to be filled with flame, it, of course, catches fire and burns like an ordinary gas jet. Even in spite of the fact that the interior of the tank may contain air enough to form an explosive mixture, the fire cannot be carried down into this mixture because the wire gauze already described will prevent the flame from being transmitted back into the interior of the tank. It is now seen that the only thing which can happen during a fire is that all the gasolene should finally become evaporated and pass out through the opening in the form of a jet, burning in the open air where it cannot cause any explosion. An explosion would, of course, throw the liquid gasolene around in all directions, thus spreading the fire and perhaps leading to fatal results for the fire companies attempting to put out the fire. Moreover, if it is possible to get through the surrounding flame, it is perfectly possible to place something over the opening in the can, which will put out the fire, and if the surrounding fire has been put out, the gasolene vapor ceases to burn. If this is not possible, the fire will continue until all the gasolene within the can has been vaporized and burned, and then, of course, if the exterior fire continues, nothing will happen except the warping and final melting of the steel can itself.

This principle has been applied by the manufacturers to large tanks of, say 40 or 50 gallons capacity, to small shop cans, to printers' cans, and in fact to every commercial size for the handling of gasolene in various quantities. They also make special tanks for automobiles, provided with these wire-screen attachments and fusible plugs, which they claim will prevent such a thing as the exploding of one of these tanks in case of accident to the automobile.

The Tests

The first test on March 26 in New York City was to take a tank of probably 50 gallons' capacity, partly filled with gasolene and build a hot bonfire under and around it. Under the influence of the fierce fire outside the tank the gasolene pressure within increased as already described, and when the fusible plugs in the top melted out due to the heat, two strong blasts of inflammable gases were projected and immediately caught fire in the open air. The tank was pushed and rolled around in every way to stir up the gasolene as much as possible and to bring the fire on all sides of the tank, but it absolutely refused to explode and nothing happened except the final complete combustion of the gasolene which had been in the tank.

After this smaller cans of 5 gallons were similarly filled with gasolene and placed in a hot fire. At the same time still smaller cans containing gasolene were used to pour the oil upon the fire, and although the streams of gasolene issuing from the outlets of these cans were constantly on fire, while being held in the hands of the operators, no explosion occurred. There seemed to be no hesitancy on the part of operators to carry gasolene in these vessels right into the immediate vicinity of the fire, and as before said, to pour their contents while burning upon the various test bonfires in order to increase their intensity.

It must be borne in mind in considering these spectacular tests that gasolene is explosive only when mixed with the proper proportion of air, and any can of gasolene would be perfectly safe in a fire provided the gasolene vapor within the can contained insufficient air or oxygen to cause an explosion. If this were the case, the gasolene vapor would burn at the mouth of the can like an ordinary gas jet, but as such a can partly filled with gasolene is almost certain to contain air in its upper part, especially when frequently filled and emptied, the probabilities are that the approach of flame would set fire to this highly explosive mixture and cause the whole can to explode, scattering the burning liquid in every direction, and setting fire to everything in the vicinity. It is just this transmission of flame back into the explosive mixture from some outside fire that these so-called nonexplosive tanks and cans are designed to prevent.

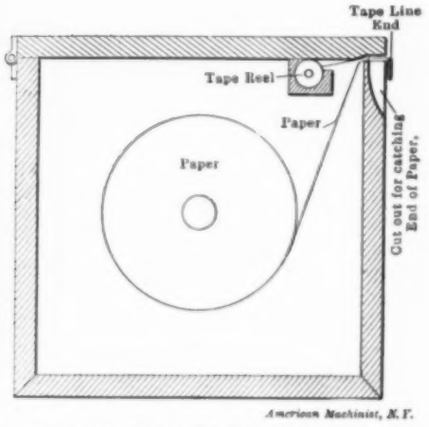
FIG. 2. PUBLIC TEST OF MCNUTT NON-EXPLOSIVE GASOLENE TANK. NEW YORK CITY

Don't Waste the Blueprint Paper

By J. F. Mirrielees

The simple little contrivance shown by the accompanying cut can be applied to the ordinary blueprint box at the cost of a few cents, and will save many times its cost in material and time.

To the under side of the lid of the blueprint-paper box, such as is illustrated herewith, is attached an ordinary rewinding reel.



CUTTING AND MEASURING ATTACHMENT FOR BLUEPRINT PAPER

The reel should be placed in the center of the length of the lid. A little recess is cut in the under side of the lid to allow the tape to pass through with the metal ring hanging on the outside. A strip of sheet metal is let in flush with the under side of the lid to keep the tape from falling and running back in the reel when the lid is raised. The metal ring on the end will keep the tape from running clear through and into the reel.

A little place is cut out of the front of the box such as is shown to enable one to grasp the end of the paper and the ring of the tape at the same time and without raising the lid. When the required length of paper is withdrawn the tape is released and immediately rewinds. The paper is then torn off straight and even with the lid of the box by a quick pull from one end of the box to the other.

The Making of Large Drop Forgings

Different Operations in Forging a 400 Pound Crank Shaft. Machines, Dies and Steel Used. Temperature at Which to Forge

BY E. F. LAKE

The size and weight of drop forgings have continually increased since this method of forming metal into the desired shapes was first made a commercial success.

Drop forgings are made by heating the metal and forming it into shape between two dies. These dies are usually made of 60 point carbon steel and parted on the center line of the forging; although the shape of the forging controls, to some extent, the line on which the dies should be parted. These dies are located in a power press, one on the anvil block and the other in the hammer directly above it.

The presses are of two kinds, one of which strikes the piece to be forged a series of blows, thus hammering it into the dies to give it the proper shape, while the other squeezes the hot metal into the dies with a steady pressure by means of presses driven by hydraulic or other power.

Operations on 400-pound Crank Shaft

In the first four illustrations are shown the different operations of forging the largest drop forging that has so far been made. It is a two-throw crank shaft that is being made by the Bethlehem Steel Company, and when finished it weighs 400 pounds. Fig. 1 shows the piece after it has been bent and heated, being taken from the furnace to the 5000-pound drop hammer for the first operation. Fig. 2 shows the piece being held under the hammer ready to drop the die on it. To the extreme left of this view is shown a corner of the heating furnace, and next to it, between the furnace and hammer, is shown the bending press. The straight bar is bent to the shape shown in Fig. 3 before it is heated for the first operation, shown in Fig. 1. Fig. 3 shows the crank shaft after it has been partly formed and as it is being taken back to the furnace to be reheated for the final forging operation under the hammer. Fig. 4 shows the crank shaft as it was being taken out of the dies after the final forming operation. In front of the hammer is shown a finished crank shaft with a 5-foot rule standing beside it to show its length.

Forging Operations

The different operations in the manufacture of a drop-forged crank shaft are best shown by Fig. 5. The illustration shows a four-throw shaft, but the operations on the two-throw, 400-pound shaft, shown in the preceding half-tones, are exactly the same. At *A* is shown the straight bar cut to the proper length. This is first bent to the shape shown at *B* in the bending press, shown to the left of Fig. 2. It is then drop-forged, and when it leaves the dies, it is similar to the piece shown at *C*. The dies are usually left ¼ inch apart, on the parting line for this size of forging to allow the excess metal to squeeze out between them, which forms into the fin that is shown at *C*. This necessitates the making of an extra pair of dies for shearing off the fins. After this is done the crank has the appearance of that shown at *D*. On this particular shaft there was a comparatively large flange on the upper end, as shown in *E*. This would be difficult to form in the dies when forging the rest of the shaft, and for this reason an extra amount of metal is left on the shaft at this point and the flange is formed in another set of dies after the rest of it has been forged. This completes the forging operations and the shaft is ready to be machined; the machined crank shaft being shown at *F*.

FIG. 1. TAKING CRANKSHAFT FROM FURNACE TO HAMMER FOR FIRST OPERATION

Steels That Are Forged

Any kind of steel can be forged in this manner, and if the proper temperature is maintained while passing it through the different forging operations, the forgings will be much stronger than steel castings. This temperature varies with the different kinds of steel, as for instance a low-carbon steel can be forged at a low temperature, and this kind of steel is usually heated to quite a high temperature and then worked under the drop hammer until it is down to a red heat. High-carbon steel, however, should not have the heat fall much below its highest point of recalescence, which is above 1650 degrees Fahrenheit, during any of the forging operations. Those forgings will be strongest that are finished just as the temperature reaches this point.

Some of the special alloy steels are very difficult to forge. Chromium steel is the most difficult of all owing to its producing a mineral hardness in the metal. If kept above 2200 degrees Fahrenheit, however, it can be forged successfully and it should never be allowed to fall below this. Nickel added to this steel, giving nickel-chrome steel, as it is called, makes it slightly easier to forge, but even then the metal should be kept at a bright yellow color during the forging operations. As steel melts at 2500 degrees Fahrenheit, this means that a forging of any size will need reheating several times before it is completely formed into shape. Some-

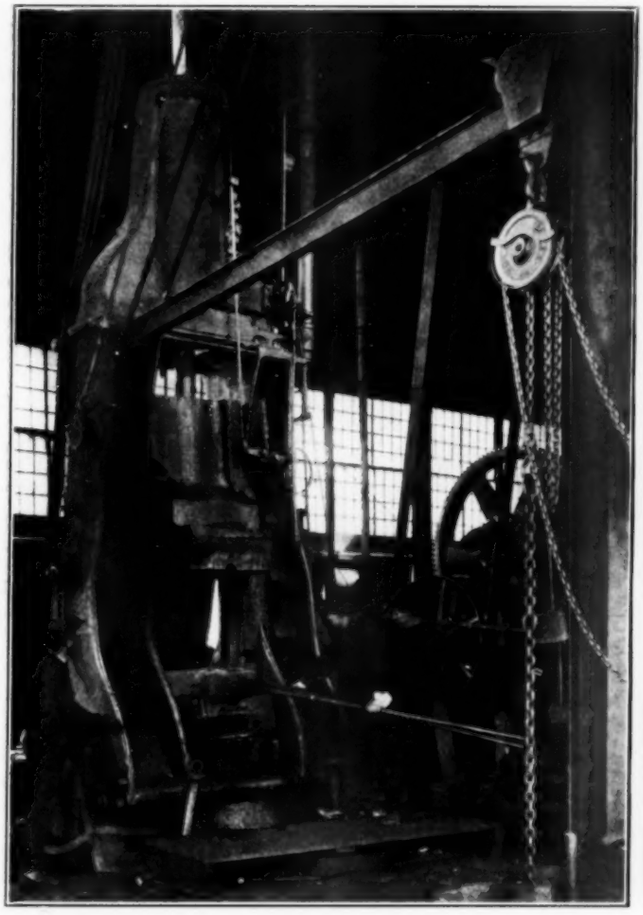


FIG. 2. 400-POUND CRANK SHAFT UNDER HAMMER READY TO DROP THE DIE

FIG. 3. REMOVING PARTIALLY FORGED CRANK SHAFT

times this is overcome by making several pairs of dies, each pair of which reduces the metal a certain amount, until the finished size is reached.

Nickel steels are more easily forged than those mentioned above, but they must be handled carefully, owing to the tendency of fissures to appear. Vanadium steels are as easily forged as the ordinary steels of 40-point carbon. Steels high in silicon have a fibrous grain and these must be forged the right way of the grain or the metal is liable to crack open, but small percentages of silicon do not affect the forgeability of steel to any extent.

Effect of Temperature on the Grain

The high temperatures, of from 2000 to 2400 degrees, that steels are subjected to when forging would seem to indicate that

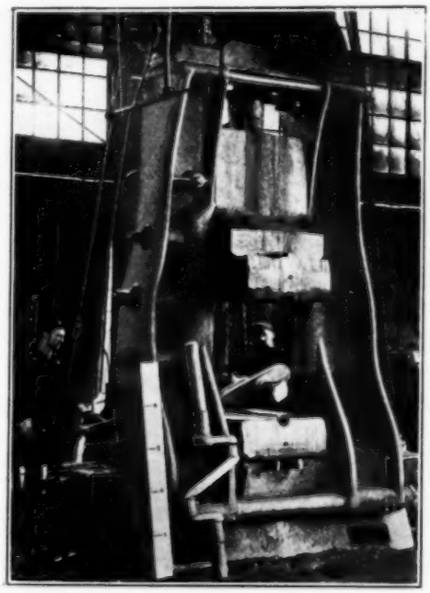


FIG. 4. FINAL FORGING OPERATION

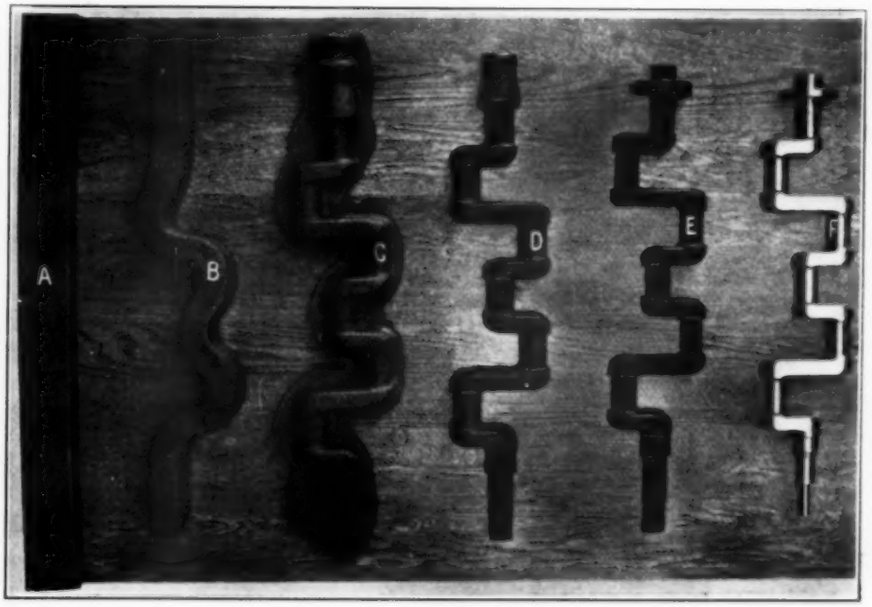


FIG. 5. DIFFERENT OPERATIONS ON FORGING A CRANK SHAFT

FIG. 6. DROP FORGE HAMMER SHOP OF THE BETHLEHEM STEEL COMPANY, WHERE THESE FORGINGS ARE MADE

the metal is weakened by overheating, but such is not the case, as forgings show greater strength than the same metal formed into shape in any other way, unless it be the rolled steels.

Steel when heated to the above temperatures, coarsens in grain and the grain becomes crystalline in nature. This makes it so mobile that it yields to distortion by the crystals sliding past one another, but as the temperature decreases the mobility of the mass becomes less, and less sliding is possible. If then forged the crystals would crush against each other; and when cool the crystals themselves will crush.

These coarse crystals, that are formed by the high temperatures, are reduced by the hammering process in the drop-hammer press, or the squeezing process in the hydraulic press, until the crystalline structure is broken up and a new grain that is much finer takes its place.

Effect on Forgings

Thus, if the piece being forged is not allowed to cool below its highest recalescence point during the forging and the forging is finished just as it reaches that point, or a little above it, a new grain structure is born that makes the metal more homogeneous. This formation of grain continues, after the steel leaves the press, until it has cooled below its lowest recalescent point, at which point it sets and no more change will take place until it is reheated to the recalescence point. These two points occur in most steels at 1650 and 1400 degrees Fahrenheit, but some of the special alloys show a wide variation from this.

Thus it will be seen that if a forging is finished while it is too hot, the grain will be coarse and crystalline and the metal will not have the cohesive force that it should and therefore the piece will not be as strong as a forging should be. On the other hand if it is hammered, or squeezed, in a forging press after it has become too cold, the crystals will be crushed and the results will be the same; but if it is forged

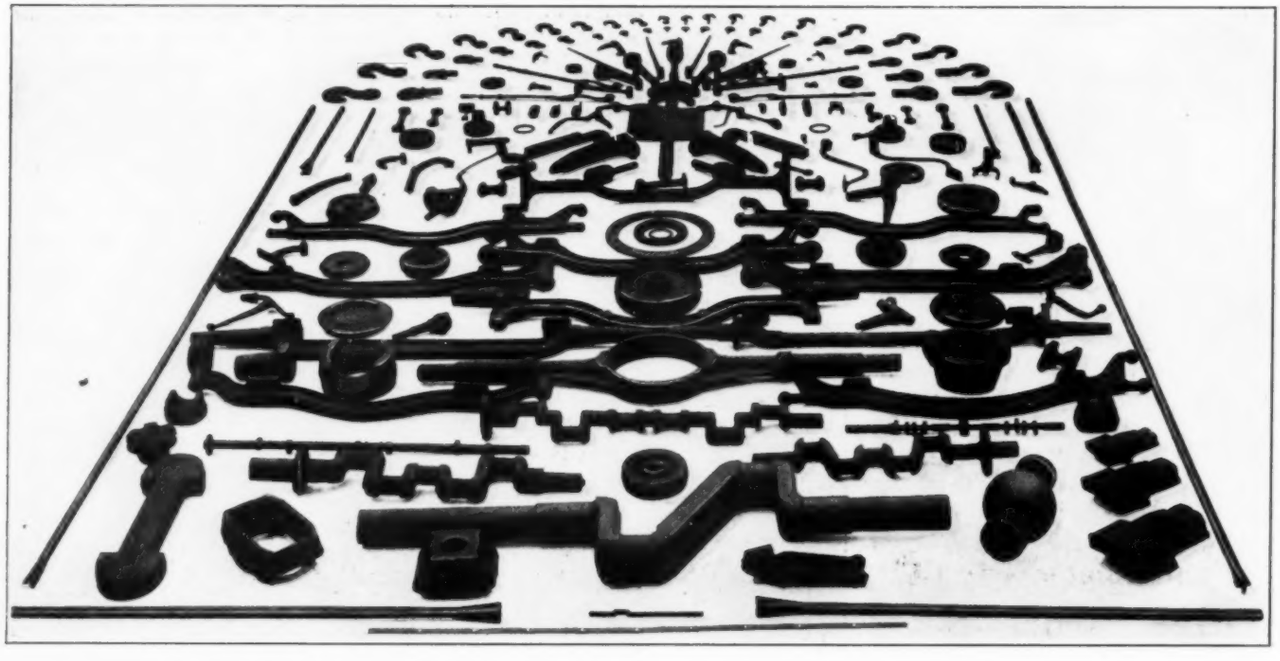


FIG. 7. GROUP OF DROP FORGINGS MADE BY THE BETHLEHEM STEEL COMPANY

at the proper heat, the grain will be fine, dense and homogenous and the cohesive force will be greater than it was in the metal before it was forged. This will naturally increase the tensile strength and elastic limit.

Forgings that are made with a knowledge of metals, temperatures, etc., and with the proper skill and care, are stronger and will stand the strains and stresses that are put upon them much better than the same steel when formed into shape in any other way, unless it be the rolled stock; which should be worked under the same temperatures.

The heat treatment that is given the pieces after they are forged is also an important factor if the greatest strength and the best wearing qualities are to be given the metal, as the best forgings can be ruined by improperly heat-treating them afterward.

Small forgings are usually tumbled, and large ones pickled in a diluted solution of sulphuric acid to remove the hard outer skin or scale that the finished forgings have. This is done so they can be machined more easily, as this skin or scale has a mineral hardness that cutting tools will not cut without becoming dull.

Fig. 6 illustrates the Bethlehem Company's equipment for this class of work and Fig. 7 gives an idea of the variety and sizes of the work done.

How One Purchaser Looks upon Catalogs, etc.

By Entropy

Recently, I have been getting prices for a shop equipment. The inquiries were sent out in such a form that the recipients could judge that business might easily result, but that it would not come for four or five months at the earliest. The variety of ways in which my inquiries were received was a real curiosity, and since most of us who are annoyed in one way or another when trying to purchase are also annoyed when trying to sell, it may be profitable to study the matter of what to do with an inquiry.

As is natural I first sent out requests for catalogs, with no reference to prices but stating in a simple manner what was in the wind. A few people ignored the request in spite of our letter heads being on a good quality of paper. Quite a few sent the desired catalog without any note accompanying it. Most sent a form letter, acknowledging my letter, stating whether they would quote direct or through agents, and offering further information. A few requested a note acknowledging receipt of catalog. A much larger number than I expected sent full discount sheets applying to their catalogs and in a number of cases where my inquiry referred to a single type of machine net prices were given, though no mention of prices was made in my letters.

When I began to send out for prices I gave the size or number of the machines wanted but no details as to equipment or attachments. About half of those from whom prices were requested gave complete replies, with prices of machine and all attachments, discounts, point of delivery, etc. Many sent price lists of everything that we wanted and said that they would be glad to name a discount when we were really in the market. Some wrote asking that we specify exactly what we wanted in the way of attachments and they would give us prices. One or two of the latter class also did not publish complete catalogs, but said that on receipt of exact specifications they would be glad to send us bulletins of that particular part of their product and quote us prices; which was quite in contrast with some other concerns who sent us complete files of bulletins of everything we inquired about and a few more for good luck and threw in a binder.

I suspect that I made my recommendations as to what should be bought about as the average man would. I paid no attention to the people who ignored our first letter except in one case where I did not know of any other manufacturer whose goods I would use at any price. It made absolutely no difference in my recommendations whether the catalog sent was accompanied by a letter or not. I went through all the catalogs faithfully and threw the letters in the waste basket. It did make a difference to some of the people who asked for an acknowledgement of receipt of catalog because in two or three cases the letter arrived and the catalog did not, so I sent for another. One or two people, surely of Irish descent, inserted the request for reply *in the catalog itself*. It was about as sensible a scheme as that of the man who wrote to a friend and told him, in the letter, where to go for the letter if it was not delivered to him promptly.

A form letter, if it has any appearance of being a form, is usually left unread. Those who sent prices at once on the request for a catalog fared better than they otherwise would, because in a number of cases I was attracted into investigating equipment that I would otherwise have passed by. To a concern whose name is known to everyone there would be no need of sending prices on a catalog inquiry, but it certainly looks like a good scheme for a young and little known concern. Secrecy about prices seems to be confined to letter writing. A visit to any one of these concerns that is close about writing its prices will develop the fact that the price on everything that might answer the customer's purpose, with every attachment that could be attached or detached, is as free as air. The same is true if their agent calls on you. How anybody expects that a customer can form an intelligent opinion as to what he ought to buy without knowning what the seller has to offer is beyond me.

The concern that sent elaborate and expensive catalogs of more things than I inquired about were probably wise, because this literature will be kept and kept in sight where it will help them get other orders besides the one under discussion.

Now it costs money to send out catalogs, and no one wants to, or should, waste money. Having once decided to send the catalog, I believe that it is a wise thing to do the thing up brown. I think it pays to send along all the literature you have that is likely to interest your prospect, though it may pay to string it out over two or three weeks' time. I believe in sending a letter at the same time as the catalog stating that it has been forwarded, not that it will be, and requesting that if it does not arrive the sender be notified so that he may send another. I believe in sending prices freely even to a competitor. He can find out anyway, so what is the use of making him work hard to get them? I believe in follow-up letters, but not impudent ones. If you send a man a catalog it is none of your business whether he is to be in the market tomorrow or the day after. I believe that one concern who sent me a catalog, a little 5-cent affair, wrote me in their fifth follow-up letter saying that I owed them the courtesy of telling them when I would buy. I felt like taking a comic postal card marked "never," and sending it back. but really the machine that they build, while not adapted to my present needs, might be just what I might want in the future, and it is not to blame for the office boy's idea of courtesy.

A word as to how I selected the firms to inquire of. I took the leading journal in each line and looked through its directory of advertisers. Whenever I saw a name that I was not familiar with I looked in the advertisements to see what he had to say, and unless I was pretty certain that he did not make anything that I wanted I wrote to him. If I had not been going into the thing so thoroughly I would have written to those manufacturers whose names I remembered which would have meant most of the people who use space in page lots.

An electric barometer has recently been invented, according to an English contemporary, which depends for its operation upon the short-circuiting of a U-shaped carbon filament by means of a barometric mercury column. The filament dips into the top of the column, and as the atmospheric pressure increases the mercury rises in the exposed part of the filament, and thus reducing the resistance. As the mercury is also affected by temperature, a second filament and mercury column is provided. In this column the tube is sealed, so that the mercury will not be affected by atmospheric conditions.

Some Test Fixtures and a Milling Attachment

Ball Bearing Carriage and Guide of Burroughs Adding Machine Are Finished and Tested with Special Attachments and Indicating Devices

EDITORIAL CORRESPONDENCE

In the tool equipment of the Burroughs Adding Machine Company, Detroit, Michigan, there are many special devices which are used in testing the various parts of the adding machines prior to assembling. A number of these fixtures are shown in the accompanying engravings.

Fig. 1 illustrates a test fixture for the casting shown in the drawing, Fig. 2; a similar casting is seen lying on the base of the fixture. This piece is the carriage for the printing frame used in the adding machine and is carried on balls, the races for which are shown at *A, A*, Fig. 2. The carriage guide along which this travels will be referred to later. A rod passes through holes *B B*, and it is essential that the center line through these holes should be a certain given distance above the ball guides *A A* and parallel to them in both directions.

The construction of the test fixture will be understood upon referring to Fig. 3, which illustrates the assembled device and various parts in detail. The work, which is outlined with dotted lines is slipped on jaws *C C* at each end of the device, these jaws being operated by lever *D* which, through the connecting arms and bell cranks shown, closes the jaws sufficiently against springs *E E* to allow the casting to be slipped into place. Upon releasing the lever *D*, the springs open the jaws *C* and the piece to be tested is held in the same way in which it afterward will be mounted on the guide in the adding machine. It will be noticed that one jaw in each pair is fixed, and the center of the cylindrical gripping jaw *F* (which corresponds in size to the balls upon which the carriage operates) is, therefore, a certain fixed distance from the longitudinal center of the fixture. On this center line are located two heads *G G* carrying sliding tubes *H H*, each of which contains an indicator arm *I* supported by a ball joint and having at the outer end a ball tip *J* to fit the hole *B* in the work, Fig. 2, and at the inner end a button-shaped head *K*, which is coated with white enamel and marked at the center with a black dot. When the tubes *H H* are slid forward until the ball tips of the indicator arms enter the holes in the piece being tested, the operator examines the ends of the tubes to see if the dot on the button *K* remains inside a small circle engraved on glass disk *L*. This end of the indicator multiplies any error located by the outer end of the indicator arm and the circle on disk *L* is of such diameter that if the dot on button *K* stays inside the circle the work is within the necessary limits of accuracy.

The fixture is mounted at an angle on a swivel base about which it may be swung easily so that either end is brought readily into position for inspection. The upper end, of course, receives the light to advantage and observation of the indicator action is further facilitated by the fact that the inner surface of the locking ring *M* is coated a dull black.

FIG. 1. TEST FIXTURE FOR ADDING-MACHINE CARRIAGE

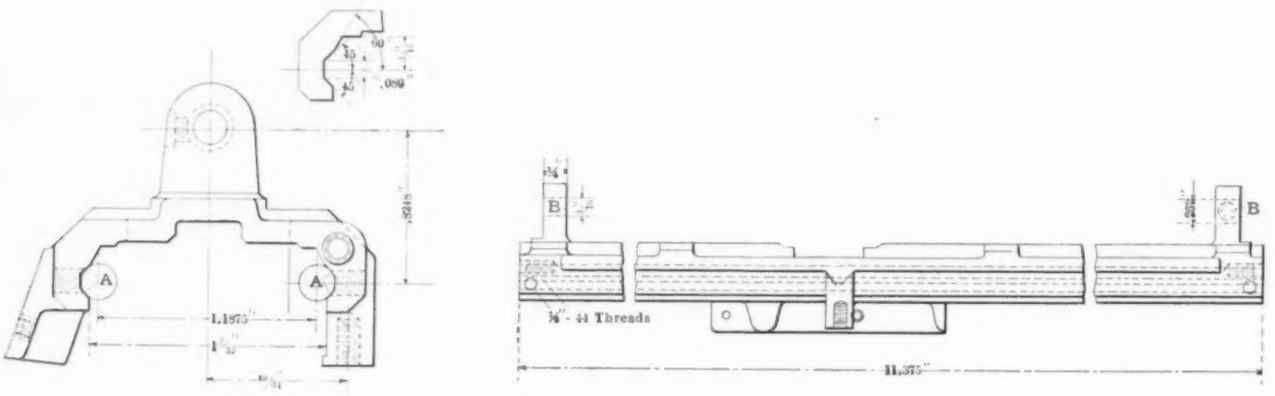


FIG. 2. CARRIAGE CASTING

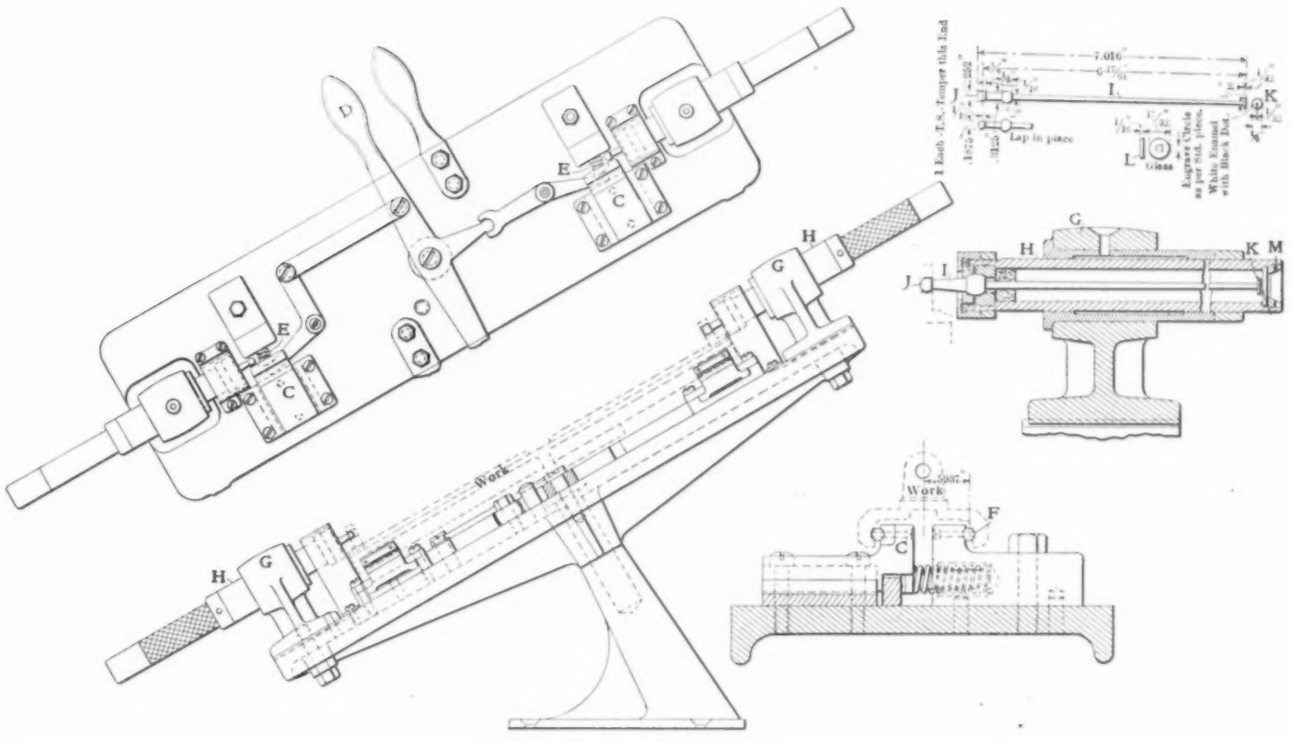


FIG. 3. TEST FIXTURE FOR CARRIAGE

TEST FIXTURE FOR CARRIAGE GUIDE

In Fig. 4 the guide is illustrated for the carriage in Fig. 2, although this drawing does not show the ball races which are milled along the sides to correspond with the ball grooves milled in the carriage, Fig. 2. The piece is, however, shown with the ball races completed in Fig. 5, which illustrates the fixture for testing the position and depth of the races. The construction and operation will be clear upon examination of this half-tone and the line drawing, Fig. 6, where the piece to be tested, is shown in position at *N*. The piece is lightly clamped on seats on this fixture by thumb nuts *O O* and two sliding heads *P Q* carrying indicators are brought into position so that the ball tips of the indicator levers engage the races or grooves milled in the edges of the carriage guide. The indicators are double affairs, each having two pointers like *R S*, which are used in combination to test the depth of the ball guide or groove and its position relatively to the bottom of the seat of the casting *N*. The accuracy of the ball race as far as the depth formed in the casting is concerned, is indicated at once by the action of horizontal pointer *R*, a line on the end of which should match a line scribed on the face of the indicator

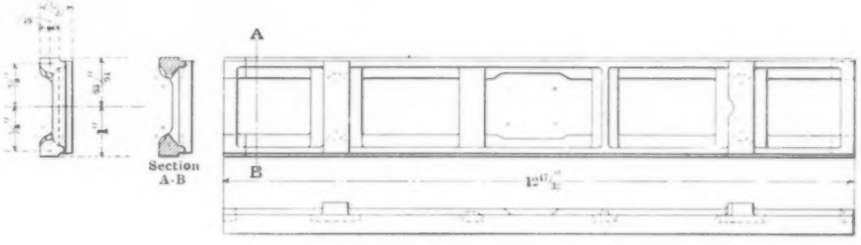


FIG. 4. CARRIAGE GUIDE

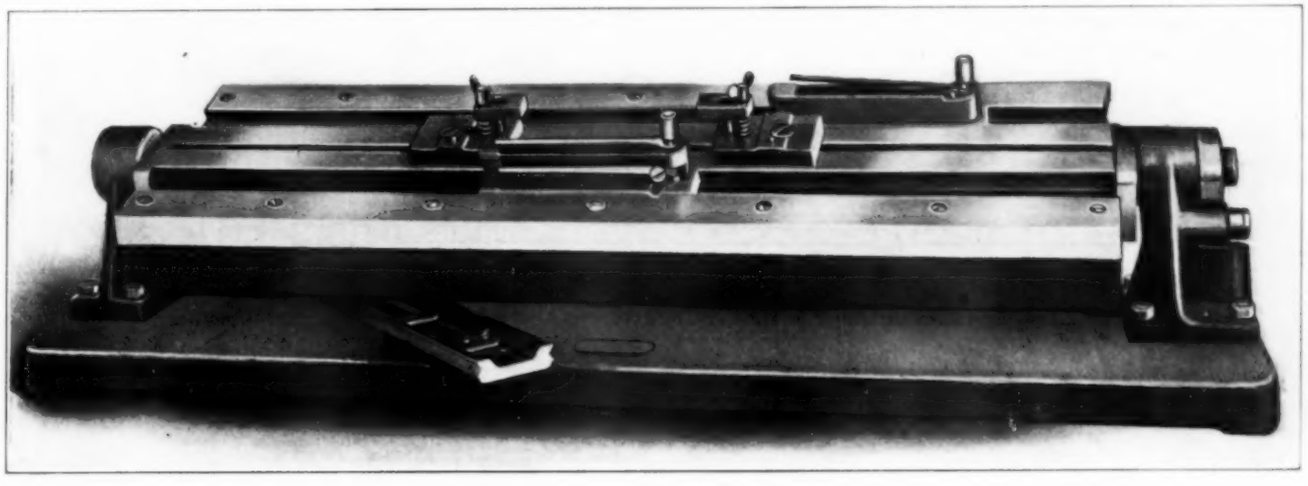


FIG. 5. TEST FIXTURE FOR CARRIAGE GUIDE

block, if the race being tested is of the right depth. If the ball race is correctly located as regards hight from the bottom of the piece *N*, when indicator *R* with its ball tip is brought into contact with the race, plug *T* upon which the arm *R* is carried remains stationary, and the second indicator arm *S* controlled by this plug stands with its line coincident with the zero line on the face of the indicator block *Q*. If, however, the ball race is high or low, plug *T* is moved vertically until the ball tip on indicator *R* is properly seated and this movement throws indicator pointer *S* up or down, showing that the ball groove is not correctly located.

The indicators may be slid from end to end of the work to test the entire length of the ball guides, and the fixture is adapted to receive work of different lengths. The spring detent *U* at the end enables the tilting table on which the piece is tested to be swung up and held with either edge up so that the action of the side indicators *S* may be observed as easily as the horizontal pointers *R*.

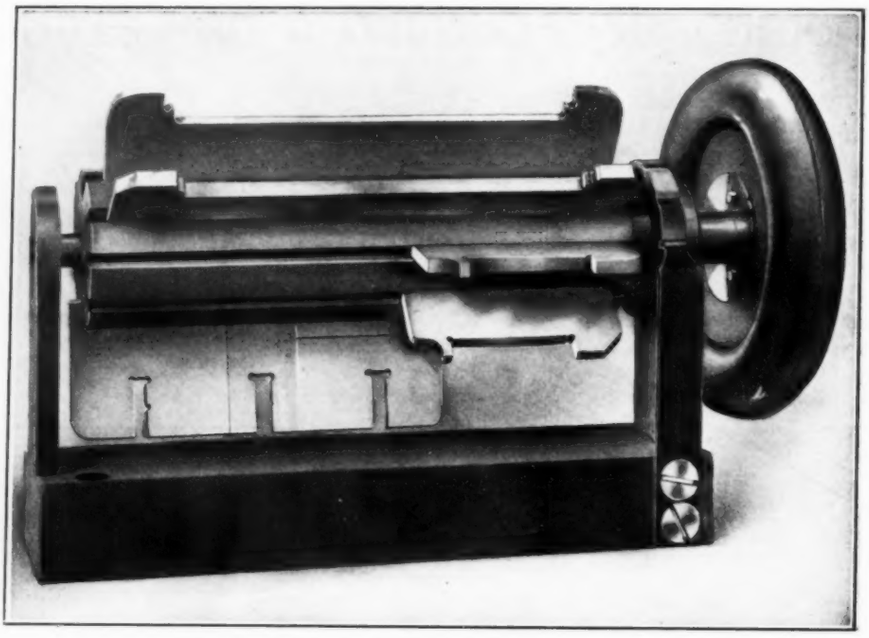


FIG. 7. A SET OF LIMIT GAGES

Limit Gages in a Holder

In connection with the test appliances shown, the gaging set in Fig. 7 may be of interest. The holder for the work gages is of wood and may be rotated by the hand in the wooden frame in which it is mounted. A spring catch at the side engages with a notched disk so that the rotary member may be held with any one of the gages in position for use. The limit gages constitute a set for testing a certain piece for over all length, length over shoulders, thickness of collars, etc. As held in the wood frame, they are not affected by the temperature of the operator's hands and are in a very convenient position for testing the work, to see if it will or will not enter the gage jaws.

A Double-spindle Milling Attachment

Figs. 8 and 9 illustrate a two-spindle milling attachment used for such work as milling the edges and ball races in the adding-machine carriage and guides. The attachment is mounted on the overhanging arm of the milling machine and the two spindles are driven by spiral gearing

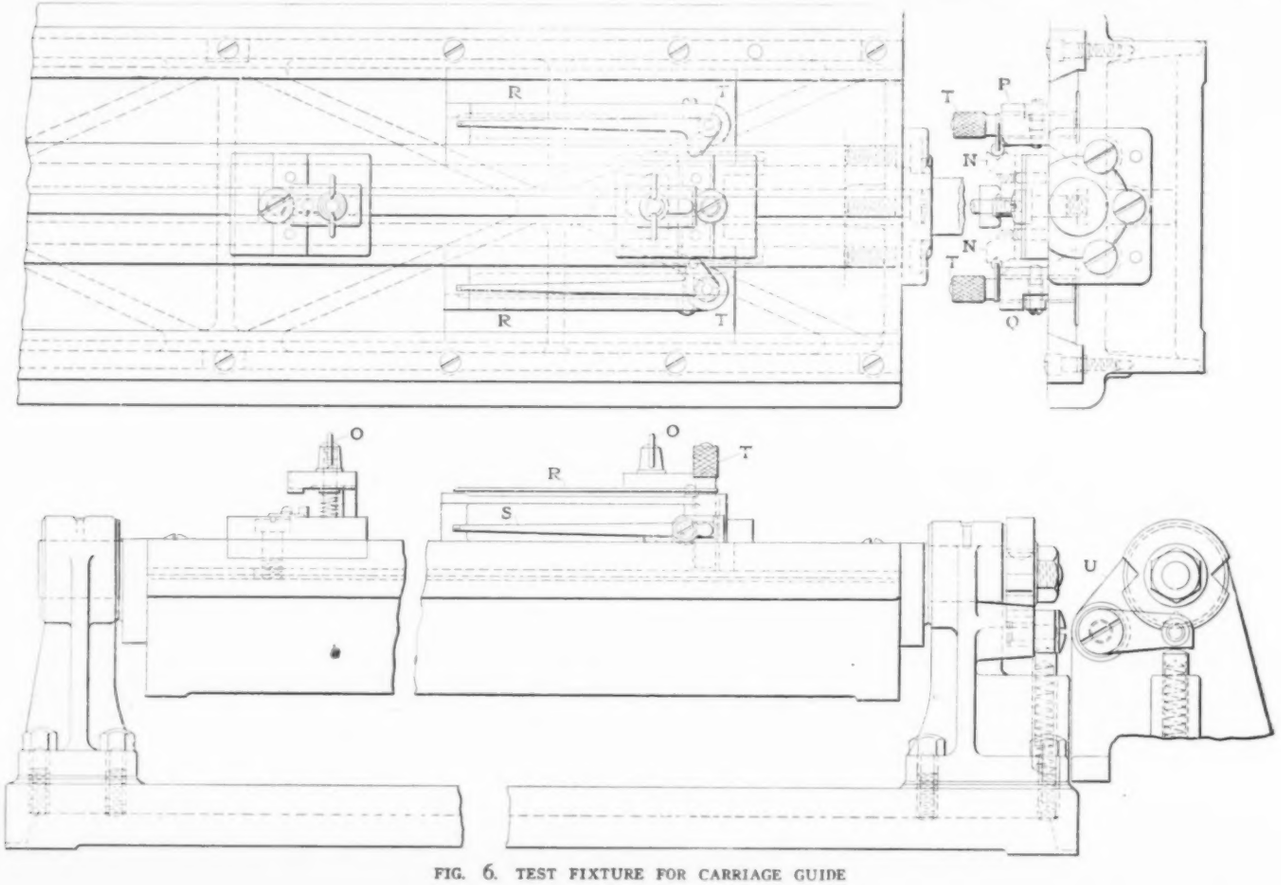


FIG. 6. TEST FIXTURE FOR CARRIAGE GUIDE

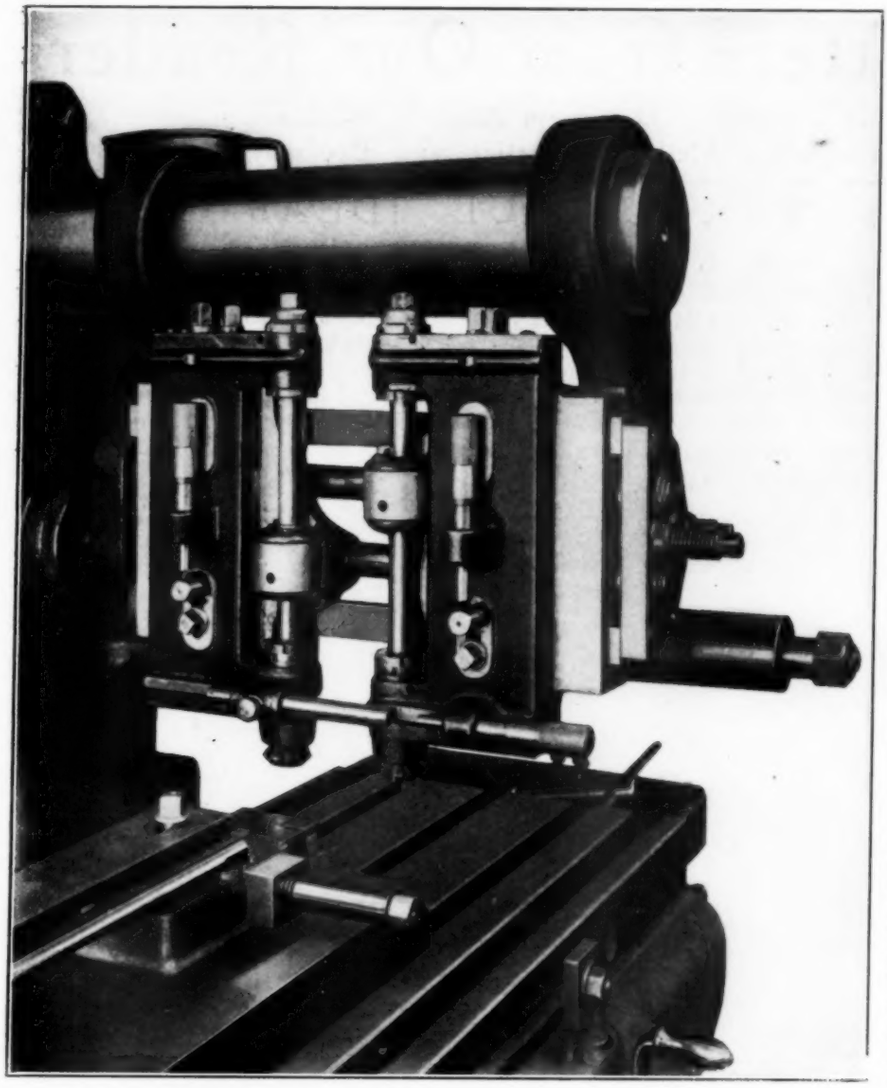


FIG. 8. TWO-SPINDLE MILLING ATTACHMENT

actuated from a driver with a taper shank entering the hole in the regular spindle of the miller. This driver is shown at *A*, Fig. 9, with spur gears at *B* and spiral gears at *C* for operating the spindles. As the spindles are driven by two horizontal shafts placed one above the other, thus enabling one set of spiral gears to clear the other, the spindles may be set very closely to one another when necessary.

Thus it is possible with a pair of cutters like those shown, to mill internal as well as external ball grooves in surfaces quite close together. Similarly straight dovetail, or other cuts can be milled by simply changing cutters and setting the spindle heads to the necessary center distance.

The heads are adjustable vertically and sidewise independently of each other and such adjustments are made very accurately by means of micrometer heads acting as stops which are arranged as clearly shown in the illustrations. It is thus possible to set a pair of cutters, like those illustrated to the exact hight required, with the corresponding surfaces perfectly alined and the edges the exact distance apart required by the work.

F. A. S.

Ten years ago gas and petroleum engines were not used in Japan, but within that period they have become so popular that they now represent nearly 15 per cent. of the total motors adopted by manufacturers. The number of factories worked by motors in Japan in 1897 was 2910, none of them using gas or oil engines; the number of factories using motors in 1906 was 4656, of which 306 were gas and 429 petroleum engines, from which it is to be noted considerable advance has been made.

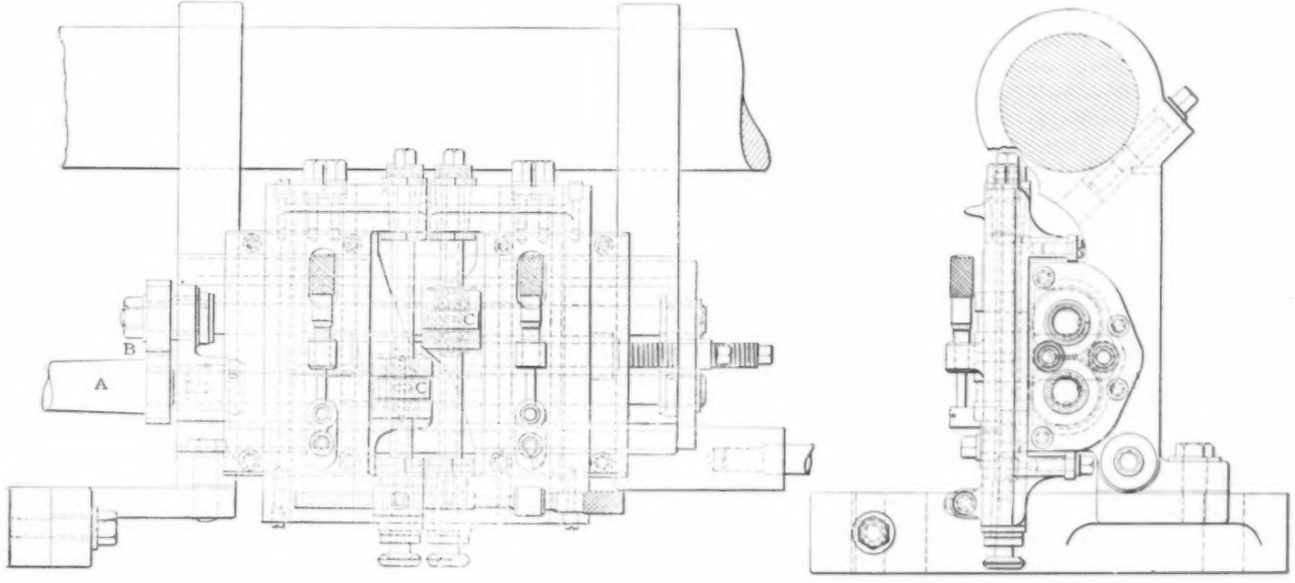


FIG. 9. TWO-SPINDLE MILLING ATTACHMENT

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Compound Die for Ball Cases

In Fig. 1 two views of a ball bearing are shown, the outer cases of which are made of sheet steel 0.025 thick. The case is in halves, one crimped around the other, as shown in the sectional view. The ball bearing proper is composed of ten 5/32 balls, a steel race *C* and the two sheet-metal parts *A* and *B*. On the surface this may look like a very simple piece of work, but to produce it rapidly and economically was found a tough proposition.

The die to be described produces the piece marked *B* in Fig. 1, this being the more difficult piece of the two to make. It was necessary to make these pieces in a compound die as in going together they must register exactly with each other in order to make a smooth-running bearing.

Fig. 2 represents plan and side elevation of the combined blanking die and forming punch, held in the press ram by

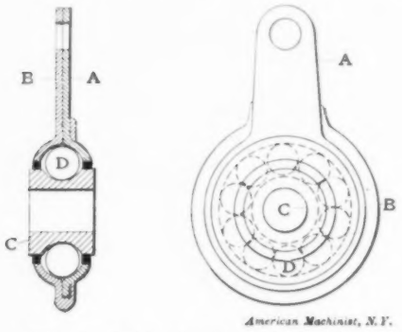


FIG. 1. BALL BEARING WITH SHEET METAL CASE

the shank *E*. The blanking die *D* is represented in detail in Fig. 3.

The forming punch and stripper *B* and *C* in Fig. 2, are shown in detail in Fig. 4. Punch *B* forms the depression for the ball race as well as holding the piercing punch *A*. Stripper *C* is worked by the cross-head *E* and plunger *I*, Fig. 2, which are operated by the automatic knockout of the press.

Fig. 5 shows sectional elevation and plan of the lower section of this die. In the elevation the die is shown in section with one punch left out for the sake of clearness. Pieces *M*, *N* and *O* constitute the punch, forming and piercing die shown in detail in Fig. 6, *M* being the punch and die holder, also acting as a perforating die for the extended arm of the work. *N* is the blanking punch acting in conjunction with *O* as a forming die. *O* acts as a forming and piercing die in connection with punches *A* and *B*, Fig. 2.

The plan view in Fig. 5 shows to advantage the position of the dies, Fig. 6. It shows also the stripper plate *Q*, which is raised in action by two rubber springs held in depressions *I I* in shoe *P*. This stripper plate supports die ring *N* by fitting

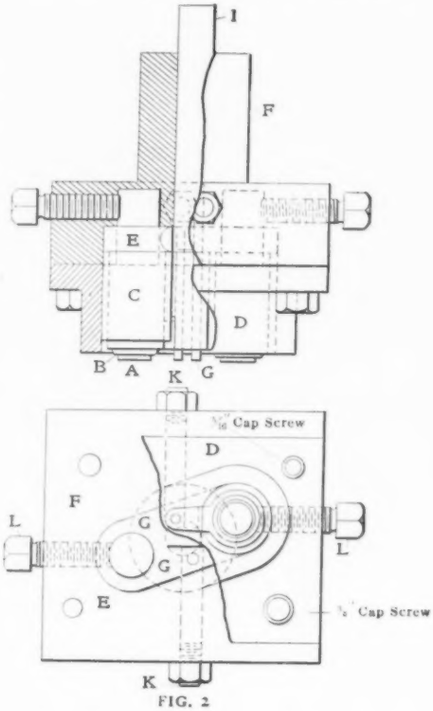


FIG. 2

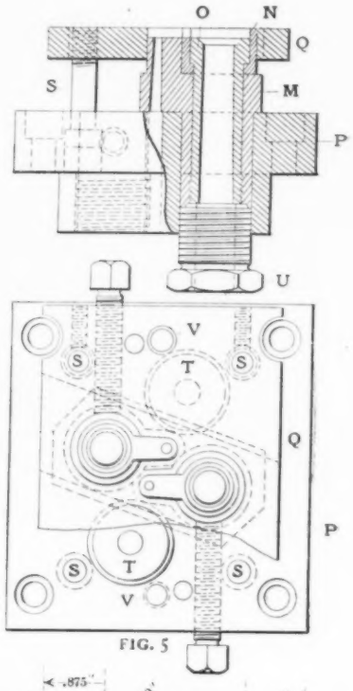


FIG. 5

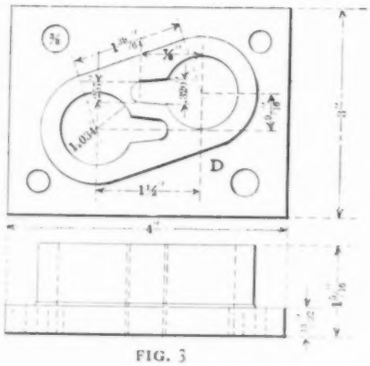


FIG. 3

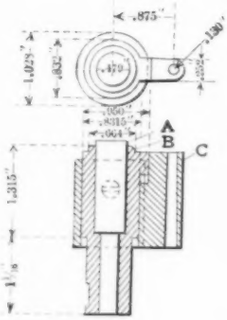


FIG. 4

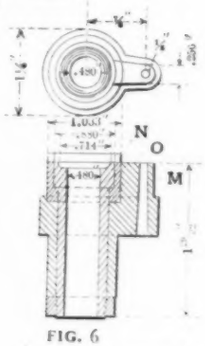


FIG. 6

American Machinist, N.Y.

COMPOUND DIE FOR BALL CASES

it closely. The plate is held in position and guided by the four screws *S*.

When setting up the die the stripper is depressed by the two cap screws fitting in the two holes *V*.

The die is used in connection with a double-roll feed, and as two complete pieces are produced at each stroke of the press 150,000 per day are easily made. Some of the construction details may look frail, but in actual use for some months the tools have proved to be excellent.

In making this set of press tools or others of like nature, there is one point that will be well worth remembering. Have a master plate for locating all holes and use this with the indicator in connection with the lathe face plate. The master plate should be made of a thin piece of sheet steel with location points drilled through with a No. 60 drill. This plate can be reversed for use on either die shoe or punch shank.

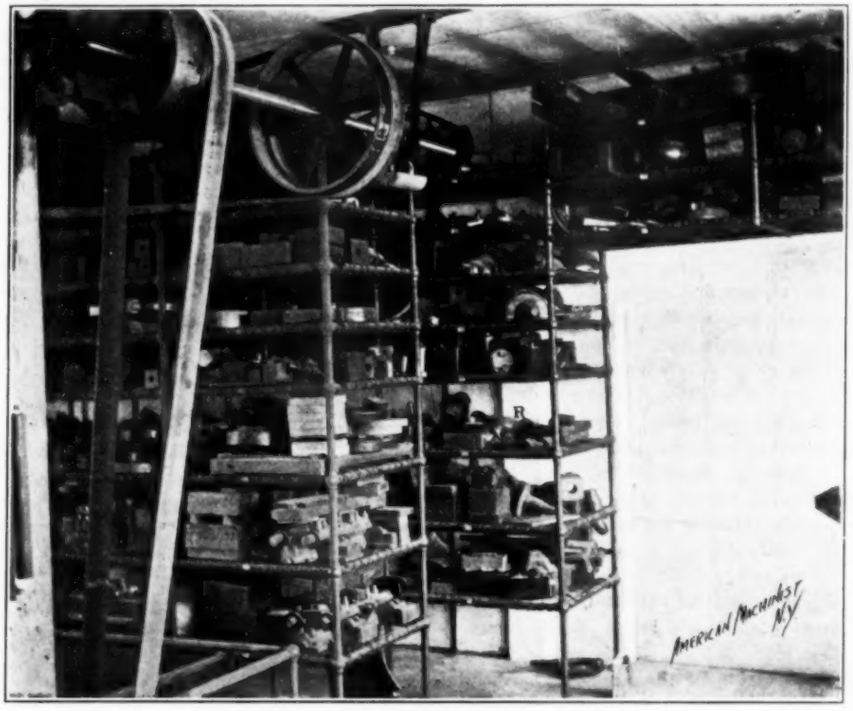
In this particular instance the only

parts ground on the universal grinder are die *D* and the punch *N* which is ground on the outside only. The punch ring *N* is the only piece that gives out. It is easily made and replaced and being carried in stock no delay is caused in replacing it.

Grand Rapids, Mich. F. C. MASON.

An All-metal Pattern Rack

When our company moved into a new fire-proof reinforced concrete building the order was given: "No wooden construction to be used, except where absolutely necessary." It became my duty to devise a rack for the patterns. The space alloted for the rack was one end of the pattern room.



AN ALL METAL PATTERN RACK

The rack is metal throughout. The uprights and cross supports are 1¼-inch pipe, while the shelves proper are of wire netting 1½-inch mesh. The ends of the wire netting are wrapped around the pipe and held by ⅛x¼-inch steel strips fastened with machine screws.

There are two separate racks, each 3 feet wide with a 2-foot passageway between. The one rack is 16 feet long. The other is the same length, up to the top of the doors and extends to the sides of the room above the doors. Both racks reach the ceiling.

There are eight shelves divided into sections by the upright supports, 4 feet long. The first shelf is 2 feet from the floor, the next three 18 inches and the remainder 12 inches apart.

Possibly on first glance this seems like an expensive rack. I do not know the cost but it could not have been much more than that of a wooden rack. The pipe work was very simple, as the joints do not have to be tight and it was very easily erected by inexpensive labor.

The whole rack, pipe and netting was given a coat of heavy black paint.

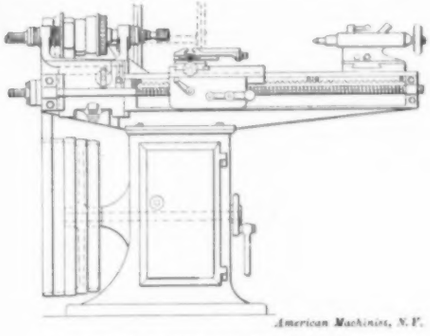
Elyria, Ohio. A. B. HOWK.

Machine Supports

We often think about analogies between designs made by man and things which we find in nature. One of the analogies that can be safely studied is that between the supporting members in nature and those in our shops. In nature we have a one-legged support holding a tree. "Firm as an oak," is a common saying which really means that the tree's connection with the ground is flexible enough so that it gives before a sudden gust of wind rather than snaps off. When nature goes beyond one leg to two it is only to support the most insecurely supported of all beings, man. Three legs are not known to nature, except in the occasional case of a lame dog. Four legs are used only to hold up the most flexible skeletons of animals and then only to make progress, or travel, possible and more safe than in the case of the biped. When nature wants anything rigid and secure she lays it on a rock. In fact the rocks themselves are our only cue from nature as to a proper machine support.

For many years we were content with resting our machinery on a solid foundation until we came to the day of multi-storied shops and light spindly lathes and planers. Then trouble began, for if a solid foundation can be secured the number and placing of legs is of minor importance, and the more of them the better, because they help to connect the foundation and the lighter superstructure at more frequent intervals, but if the foundation is insecure the more legs the more danger points, and since all shop structures are more or less liable to distortion the machine itself will follow the building.

Beyond a certain rather short length the expedient of using three legs has to give way, for something must be provided to hold up the middle of a long lathe bed, and a planer must be held up under the housing corresponding to two points of support and then there are the two ends to be held up. Fortunately on very long lathe work the general straightness of the bed has little to do with the accuracy of the resulting product. While the lathe bed may and usually does conform itself to the risings and fallings of the shop floor the accuracy of long work depends almost entirely on the skill of the man who manipulates the follow and center rests.



A SINGLE-LEG LATHE DESIGN

Then there is left a planer as the most troublesome of all machine tools to design. Only one way seems possible and that is to put the machine on a foundation reaching to solid rock. To put a planer on a second, or tenth floor, if it is not of the shortest size, is to invite poor work, since every new piling of castings on the floor around it will throw it out of true. Persuade people to put planers on a rigid foundation and our worst trouble is over. Except for the bother of cleaning out chips a planer bed might just as well be all legs or rather set directly on the foundation the whole length.

What brought out the foregoing, however, was a clipping from the *Patent Office Gazette*, which my friend, Clegg, of *Castings*, sent me. This machine is built on the "tree" plan with a board base, substantial trunk and two horizontal limbs. There is no need of shortening the left-hand member so much. This design with minor modifications could readily be applied to larger lathes than the one shown appears to be. Two cantilevers of a length each equal to one-half

the length of an ordinary lathe bed will give exactly the same deflection as the ordinary lathe bed loaded in the middle. It is customary to build 16-, 18- or 20-inch lathes without a center leg up to 8-foot beds. With the central supporting column 2 feet wide, 8-foot beds could be put on a single column with no more danger of spring than in the case of an 8-foot bed, as ordinarily built. I believe the thing would be fully as satisfactory as the three-point support disguised in the rear leg used now by a few manufacturers, and its torsional stiffness for the same total length of bed would be twice as great which would be a strong point in its favor.

Springfield, Mass. ENTROPY.

A Chilled Sandblast Nozzle

After the installation of the sandblast machine for cleaning castings, it developed that the nozzles were going to be quite an item of expense. The nozzles which were furnished with the machine were made of cast steel, and, of course, were machine made, hardened as hard as carbon steel can be hardened. In spite of this they would only last about two hours. As these nozzles cost about four cents each we thought that by a little expense in the experimental line, we could better it. The result was that we made a nozzle which lasted for eight hours, and at next to no expense whatever apart from the cost of equipment.

Fig. 1 shows a chill which was made for casting the nozzle in. This nozzle is

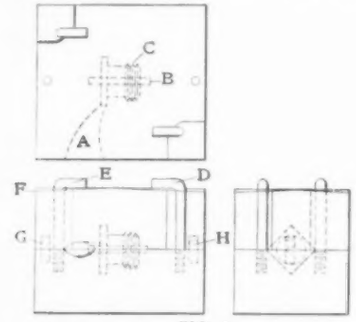


FIG. 1

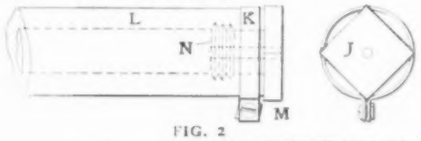


FIG. 2

American Machinist, N.Y.

A CHILLED SANDBLAST NOZZLE

a complete departure from what was furnished by the makers. We made it the form of *C*, *J* and *N* show it in the hose *L*, in Fig. 2, with the hose clamp *K* holding it in place.

The patterns for the chills were of plaster-of-paris, made from a master nozzle. The chills are clamped together with two bolts *D* and *E*, and doweled with two pins *G* and *H*. *F* shows a bevel which makes the clamping bolts more effective. An ordinary No. 4 Morse taper pin is used to core the hole at *B*, and, of course, the master nozzle must be made with prints for this, so that the chills will have the proper formation to receive the taper pins. These pins must be coated with one of the steel-core compounds which are furnished by the foundry-supply houses. They are then laid in position, and the chills clamped ready to pour. A small percentage of manganese in the ladle will be of benefit, this percentage to be found by experimenting, as irons vary from different cupolas to such an extent that this cannot be fixed. *A* shows the gate of the chill.

A number of these chills can be made, and put on a frame together. The cores can be used over and over again, if ordinary care is taken in driving them out.

Utica, N. Y. J. W. Y.

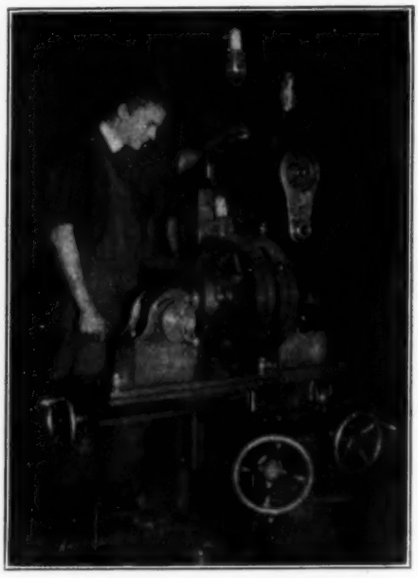
Cutting Large Gears in Small Milling Machine

The illustration shows how a fairly large job was handled with the tools of a small shop. Sixteen blank gears came into our shop, which were 15 inches diameter, 1⅝-inch bore, 2 inches wide, to be cut 8-pitch, 118 teeth. The only machine we had that we could use for this job was a homemade plain miller, and as our index-head center only came 6 inches above the table of the machine we had to block up under the index head and tailstock to swing the gear blanks.

We got out two cast-iron blocks, as shown in the photograph, which were 6 inches high and a little longer and wider than the bases of the headstock and tailstock. We milled the bottoms of the blocks off first, leaving a tongue running across the middle to slip into the T-slots of the machine table like those on the bottoms of the headstock and tailstock, so they would always come in line. When the bottoms of the blocks were finished we reversed them, placing the tongues in the T-slot of the table; then we milled off the tops, cutting a groove along the middle for the tongues in the bottom of the index head and tailstocks to fit into. We clamped them to the table by means of lugs which were cast on each end at the bottom and clamped the index head and tailstock to them by drilling and tapping the tops for cap screws which went through the bolt holes in the bottoms of the head and tailstock. This gave plenty of room between the centers and the top of the table. So we tackled the next difficulty.

This was spacing the gears; none of our index-head plates would space 118 teeth, nor could we space them by compound or differential indexing, as our index plates fastened to the side of the head, so we had to index a plate to do the work with. To do this we turned up an arbor and fitted the sample gear which had come with the blanks on one end and put one of the index plates on the other end. Then we placed the arbor between the index centers without fastening it to the head, so it could be turned freely.

We then placed a cutter in the miller which would cut a slot that the latch pin of the index head would slip into snugly and adjusted the machine to a position that would allow the cutter to form a



CUTTING LARGE GEARS ON A SMALL MILLING MACHINE

slot about as deep as it was wide in the edge of the index plate on the arbor between centers.

We wanted to cut 59 slots in the edge of this plate using the gear on the arbor, which had 118 teeth to do the spacing with.

To do this we made a gage of a piece of ⅜-inch round iron, bending one end over sharp and flattening it out to slip between two of the gear teeth and pointing the other end which was to seat in a center-punch mark in the table at one side of the gear. We made this long enough to reach half way up the side of the gear when the point was in place on the table. This gage when it was in place prevented the gear from turning in one direction, and a piece of ⅛x1-inch stock placed under the side opposite the gage from between two of the gear teeth to the table, held it from turning in the opposite direction; thus the gear was held steady while slots were being cut in the index plate. To space these the gages were placed in position, a slot cut in the plate, the gages removed and the gear turned until two of its teeth had passed the gage. The gages were then placed in position again and another slot cut; this was repeated until 59 slots were cut in the index plate, which number completed the circuit of the plate.

We then removed the plate from the arbor, placed it in position on the index head, adjusting the latch pin so it would engage in the slots and were ready for the gear blanks. An arbor was made that would hold four of these at once, this being the largest number we could get between centers, and as the blanks were keyseated 7/16 we keyseated the arbor and keyed the blanks to it to obviate any possibility of slipping. We then placed a dog on one end of the arbor, placed it between centers and finished the gears in the regular way, indexing 20 holes in the 59-slot circle for every tooth.

Govans, Md. F. E. FICK.

Cutting an Awkward Keyway on the Planer

In the sketches an easy way to cut an exceedingly difficult keyway is shown. The idea of using the platen of a planer to do work while the cross-rail is run clear up, out of the way, seems to have been little enough considered heretofore, but we now and then do this. Anyway, no shop can afford to send work to "the other fellow."

Fig. 1 shows the job in section and the general dimensions are given. In the 3-inch bore a 5/8-inch keyway was to be cut, clear through, from end to end. There was considerable discussion of the job at first, but finally it was put on a car and sent down to the big Pond planer. The cross-rail was run up as high as it would go. Then the crane was called into service and the cylinder was set on four V-blocks and clamped down. A length of 2-inch cold-rolled shafting was next obtained and a 5/8-inch hole drilled through it near the center; then a hole was drilled and tapped at right angles to the first for a binding screw, as shown in Fig. 2. A short bar of 3/4 tool stock was formed at the end into a 5/8 square-point tool, the body turned to 5/8 for 2 inches and cut off. Then a 5/8 set screw was obtained and a good third of the head filed off; the rest of the head was let into a shallow counterbore. The 2-inch shafting was only tried with a line for truth and then pushed through the bore of the cylinder.

The carpenter then put up in front of the planer a few feet from the bed, a 6x6 upright and "toenailed" it to the floor, a 4x4 brace being put up at each side and behind it. A 2-inch hole was bored through an inch board and the board nailed to the upright. One end of the long shafting was placed in this, and behind the planer a similar bracework was built up, only here a 2-inch hole was bored clear through the "6x6" to receive the free end of the shafting. An old, narrow-face pulley was put on the shaft and its two set screws clamped down hard. Then with C-clamps, the pulley was clamped to the post. These posts, by the way, were set up by line, using a T-slot for a guide.

The work was pulled to and fro by hand several times, to be sure that all was right. The work was then run past the drilled holes in the shaft and in the plain one (drilled for the tool as in Fig. 2) a rod about 2 feet long was put and with a square was set plumb. Then the keyway tool was put in, the set screws put in place and screwed up lightly. By means of a square the tool was set for depth of cut and the set screw then set up tight. The work was then pulled along the tool, just taking a skimming cut. When everything was properly adjusted the arrangement worked nicely.

At both ends of the job two angle plates were set as in Fig. 3, 3 inches apart. A small pulley with 3/4-inch bore was put between them, and a bolt served as its axle, the head on one side and the nut on the other keeping it from working out. This served as a rest for the 2-inch shafting, and kept the job from being ruined by the spring and vibration of the shaft and consequent chatter of the tool. Light cuts were necessary. At each cut, of course, the planer had to be stopped and the tool reset.

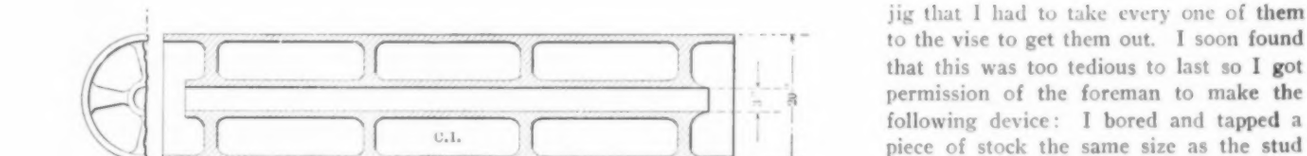


FIG. 1

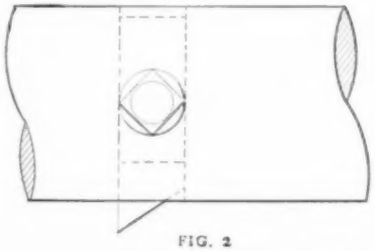


FIG. 2

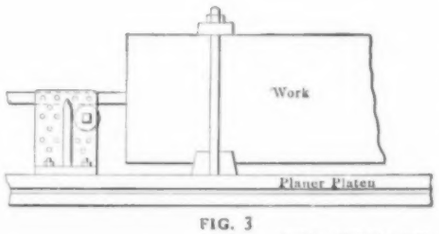


FIG. 3

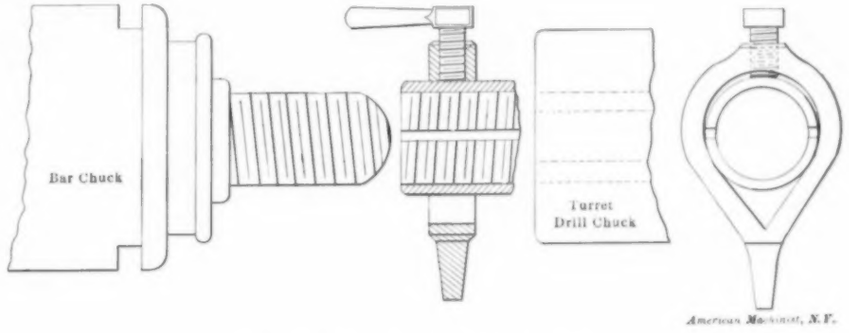
American Machinist, N.Y.

CUTTING AN AWKWARD KEYWAY ON THE PLANER

Albany, N. Y. JIM.

A Stud Extractor for the Turret Lathe

A short time ago I had a few gross of 7/8 studs to thread on both ends in a turret lathe. I found that on threading the second end the automatic die drove the end of the studs so tightly into the screwed jig that I had to take every one of them to the vise to get them out. I soon found that this was too tedious to last so I got permission of the foreman to make the following device: I bored and tapped a piece of stock the same size as the stud and slotted it down the center with double hack-saw blades, thus making a clamp for the stud. Over this clamp I put a carrier, as in the sketch, which I used for tightening the stud clamp. I turned down a shank on the end of the clamp to fit the drill chuck in the turret head. Then it was a very simple job to run the newly threaded end of the stud into the clamp, tighten the carrier, reverse the machine, unclamp and take the finished stud out of the stud extractor thus made. I was able to turn out 50 per cent. more work by the use of this device.



American Machinist, N.Y.

STUD EXTRACTOR FOR THE TURRET LATHE

Chelmsford, England. ARTHUR COOKE.

The Automobile on the Farm

With the coming of the automobile to the farm what could be more natural than the desire to utilize its splendid power plant for other purposes besides that of propelling itself over the roads? An ingenious farmer has solved the problem in a manner apparently satisfactory to himself.

His dairy and barn being over a mile from his home, he uses an automobile, a medium-priced touring car of standard make. His first attempt at running the dairy machines, separator, churn, etc., was to run a belt from one of the jacked-up wheels of the car, the belt running on the curved surface of the pneumatic tire without trouble. This arrangement, however, caused undue wear on the differential by reason of one wheel's doing all the turning, and was otherwise objectionable on account of the inconvenience of lining up the car every time to make the belt run properly.

To overcome these objections, our ingenious friend devised an arrangement whereby the act of putting the car in its shed places it in position and so associates it with the machinery of the dairy that it is sufficient to start the engine, throw in the high gear, and regulate the speed to the load.

The accompanying sketch shows this device so plainly that it is not necessary to describe it other than to call attention to the two rollers, one of which has its shaft extended outside the box to carry a pulley from which the belt runs to an overhead shaft. It is easily apparent that the revolution of the wheels of the car will cause a reverse motion of the rolls which is transmitted by means of the pulley and belt to the shaft and thence to the machinery.

In this way the wear on the tires is rendered uniform and that of the differential eliminated entirely. The grip on the rolls that these tires exercise is surprising.

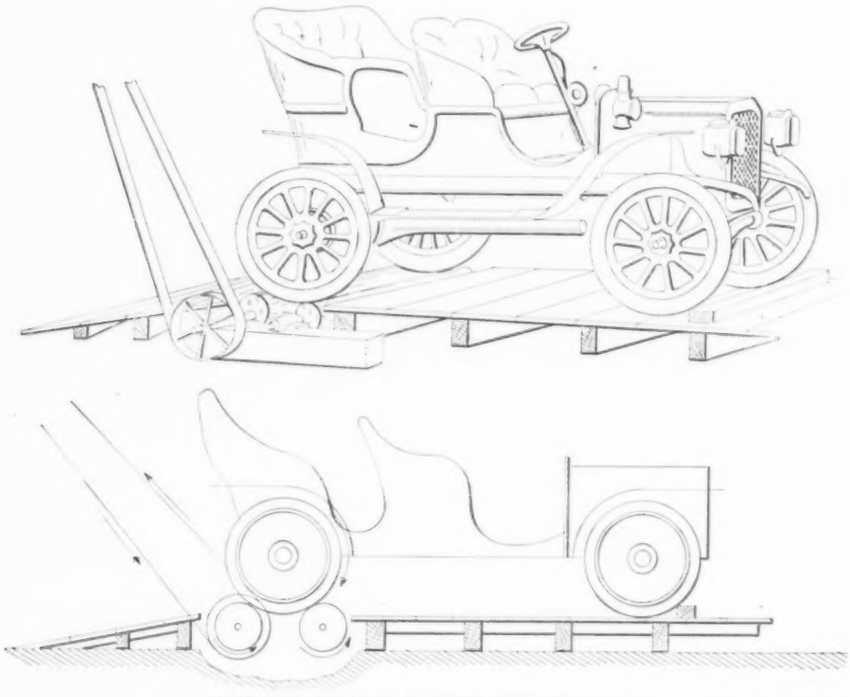
A peculiarity of this arrangement is that the car shows a tendency to skid from side to side. This, however, is easily overcome by means of props or bumpers which are put in place so as to limit the sidewise motion of the car within the shed, the mere pressure of the hand serving to move the car easily when the wheels are revolving on the rolls.

In very warm weather or on long heavy pulls, it is sometimes necessary to connect the circulating system with the water supply in order to prevent heating of the cylinders.

For sawing wood, cutting feed, or any work of an intermittent nature, it is necessary for someone to control the engine on account of there being no governor. As a matter of fact, our farmer has a small boy at the throttle most of the time as the separator is sometimes thrown off without warning.

The above shows how one man, at least, is getting good work out of his automobile, bad roads and bad weather notwithstanding.

Sumter, S. C. S. C. McKeown.



AN INGENIOUS WAY OF USING THE AUTOMOBILE *American Machinist, N. Y.*

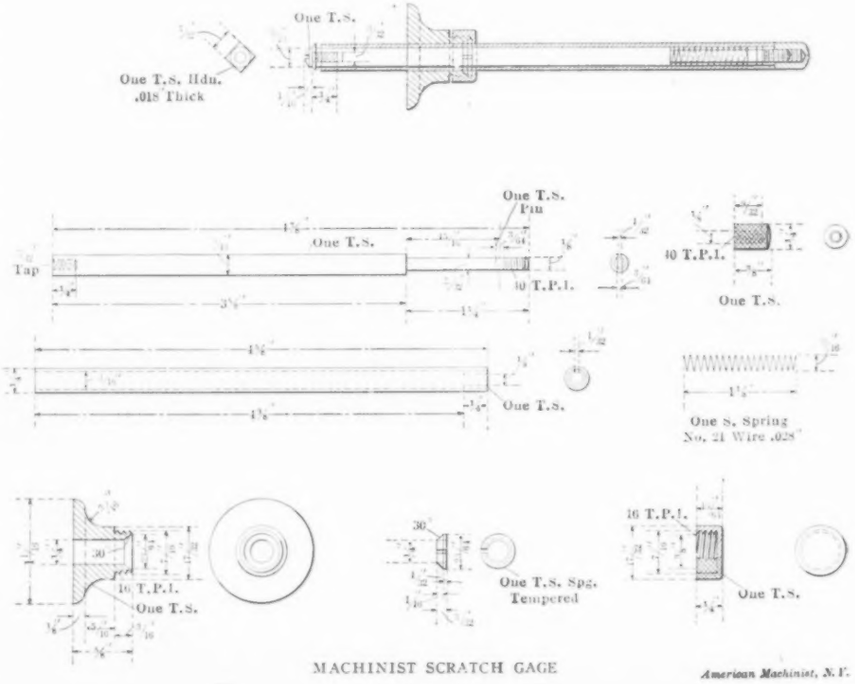
An Improved Machinist's Scratch Gage

This improved scratch gage is intended for machinist and toolmaker use where close work is required. As one will readily see by looking at the line cut, a very fine adjustment may be obtained by the nurled nut on the end of the bar.

If my brother mechanics will make one of these tools (as they cannot buy one) and try it I am sure they will be much pleased with the results obtained.

It will be quite unnecessary to describe the manner of making the device as the detail drawing is quite clear and shows every part.

Waterbury, Conn. Geo. Aldington.



MACHINIST SCRATCH GAGE *American Machinist, N. Y.*

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Fixture for Milling Corliss Valve Stems

The article on the above subject by H. L. Dean at page 256 interested me, as I know of better and far simpler jigs for doing the same work. These jigs are used in the Ball Engine Works, Erie, Penn.

The stems are machined all over to size with the exception of the sides of the T-head which are left rough. The key seat is then milled in the desired position. The halftone, Fig. 1, shows the jig for finishing the T-heads in exact relation to the keyways.

It consists of a bracket *A* bored a snug, sliding fit for the stems which, by the way, are ground to size.

Two clamps *B* are provided on the bracket *A* for securing the valve stem when it is properly located.

A steel block *C* is bored a sliding fit for the stems and a keyway is cut in the same size as the keyways in the stems. The block is then accurately squared with the hole in the center and the keyway perpendicular to the center of one of the sides and hardened. In some cases the keyways on the valve stems are in line with the center of the narrow way of the T-head and in others with the long way. With this rig either can be accommodated without any "rigging up." A distance piece or hight block *D* is provided for the squaring block *C* to rest upon.

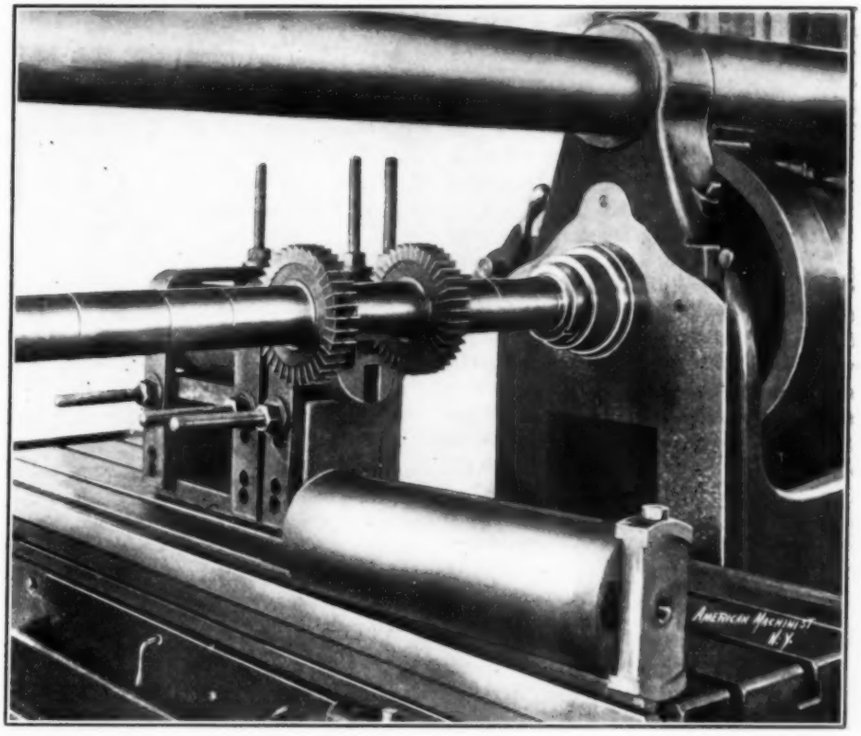


FIG. 2. SLOTTING THE VALVES

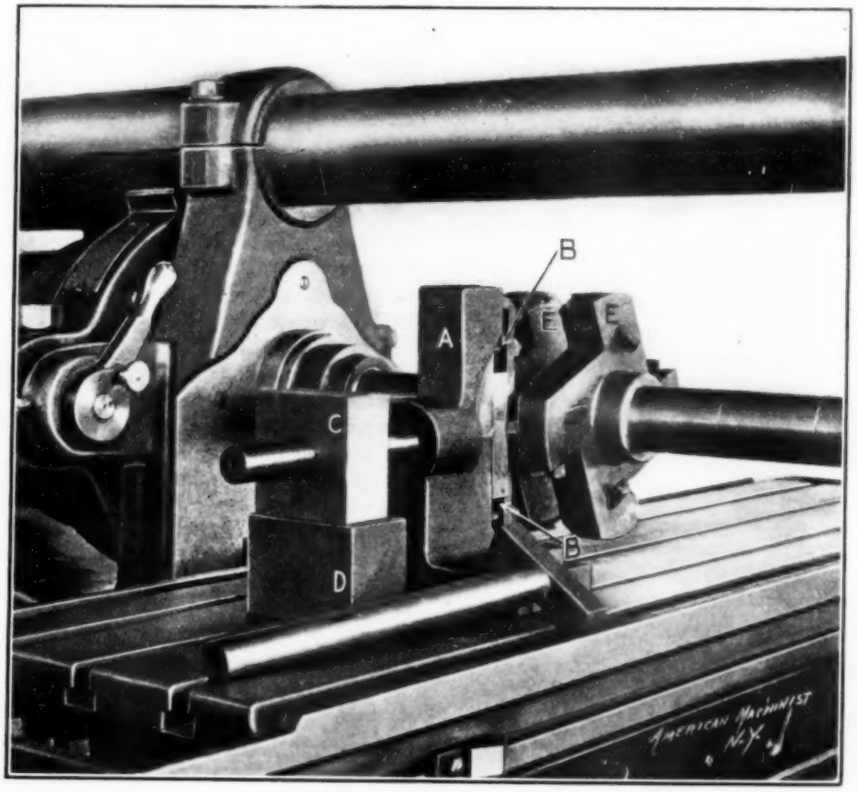


FIG. 1. MILLING THE T-HEADS

The straddle mills *E* are made of cast iron with inserted teeth of high-speed steel, and are easily adjusted the correct distance apart and in line with the center line of the valve stems.

In practice the milling-machine table is run back. The clamps *B* turned one-quarter way 'round and a stem is inserted in the hole in the bracket *A*. A Woodruff key is then put in the keyway in the stem and the square block is slid on the stem and over the key. This squares the stem in the bracket *A*. The clamps *B* are then tightened and the feed is started. I tried several of these stems in the slots in the valves and they came as near being interchangeable as any work I have ever handled.

Fig. 2 shows the jig for machining the slot for the T-head in the valve. The valves are first centered on both ends and rough turned all over, after which they go to the milling machine to have the slot in the end for the T-head milled.

The jig for holding the valves is a simple V-block with the sides of the V at 90 degrees. One side is horizontal as shown in Fig. 2 and the other side, obscured by the milling cutter and valve, is vertical. Three angular clamps are provided with vertical and horizontal studs as shown. The object of making these clamps so long is to accommodate the many sizes of valves required. The milling cutter nearest to the spindle nose is solid and for taking the roughing cut. The outer mill is a pair of interlocking cutters used for finishing. Two stops are used on the cross slide of the milling machine, one for roughing and the other for finishing. Both roughing and finishing are completed at one setting of the valve in the jig.

After the valves are all slotted they go to the grinders, where the one end is centered on the original center which was used in rough turning. The steel piece shown in Fig. 2 fitted to the end of the valve lying on the milling-machine table, is used to center the other end. This steel piece is very carefully made and has a tongue exactly central with the center on the opposite side. This tongue fits the slot in the end of the valve. The valves are finished 0.004 smaller than the chambers which they fit and it has been found that when heated they expand just about this amount and fill the chamber.

New York. E. A. DIXIE.

Green Sand Molds for Steel Castings

On page 168 of the AMERICAN MACHINIST appears an article entitled "The Making of Large Drop Forgings," but which is really a description of a most interesting steel casting. It is evident that the printer by mistake used the wrong heading, and I do not write to direct attention to his error, but to one the writer of the article makes in speaking generally of steel molds. He says: "To pour the hot steel in molds filled with green sand, that has not been dried out, would cause the gases to form so suddenly that they would cause an explosion." If this were true, it would logically follow that an effort made to pour steel into green molds, if not disastrous to life or property, or both, would be certain to produce castings of little value.

It is known to many that there are hundreds of tons of steel castings poured daily into green-sand molds that are not even "skin-dried," and perhaps to a lesser number, but to all steel founders is it known that green-sand cores in these green-sand molds are extensively used. To some persons the perusal of the article describing the snail case might give the impression that if they buy steel castings they should by all means be made in dry molds, for otherwise they will not be supplied with sound castings. I trust that such an erroneous impression may not prevail, for it will not benefit either the consumer or the producer.

Some time ago the writer made some determinations concerning the specific gravity of cast steel, incidental to which definite conclusions were reached as to the relative homogeneity of steel cast in dry- and green-sand molds. He found that steel cast in molds (with no cores) that are baked in an oven several hours, has a specific gravity of 7.856, or a weight of 0.28353 pound per cubic inch, and 489.94 pounds per cubic foot. Also that steel cast in skin-dried molds, with all cores baked, has a specific gravity of 7.72, or a weight of 0.27861 pound per cubic inch, and a weight per cubic foot of 481.45 pounds. Furthermore, that steel cast in green-sand molds without any cores, dry or otherwise, has a specific gravity of 7.522, a weight of 0.27145 pound per cubic inch, or 469.07 pounds per cubic foot. This was an average of several specimens and the conditions surrounding the tests were identical with those in daily practice.

From the above, we see that cast steel made in skin-dried molds has 1.7 per cent. less density than steel poured in baked molds, and that steel made in an absolutely green-sand mold not only does not "cause an explosion," but has its specific gravity lowered by only 4.3 per cent. below that found common to steel poured in thoroughly dried molds.

Bearing this in mind, and the additional important fact that green sand affords much less resistance than dry sand to natural shrinkage, it will be readily seen that there should be no indiscriminate criticism of the former molding method, much less a condemnation of it, when the fact is considered that frequently reduced homogeneity is a lesser evil than shrinkage strains produced by the resistance to free contraction offered by a hard, dry mold. In recent years green-sand molding in steel has justly come into its own, and is one of the chief means by which the steel founder has been enabled to furnish sound castings of intricate design to the consumer at a price which has made their use possible, and their manufacture a commercial foundry proposition.

Granite City, Ill. R. A. BULL.

Too Much System

The article by Mr. Jackson showing the effect of too much system struck a tender chord with me and I venture to give my own experience as follows:

THE TOO SYSTEMATIC SHOP

There's a shop just over the way,
Where I worked for many a day,
But things are so changed,
That all things are arranged,
And the men have nothing to say.

No matter what comes in to turn
The men have nothing to learn,
They don't need to have brains
To go in when it rains,
But the office has knowledge to burn.

And no matter what kind of steel,
Great chips from the bar they must peel;
They must mow them away
As the farmer does hay,
Or the wrath of the boss they will feel.

When I asked for a certain shaped tool
The foreman said I was a fool,
For 'twas not in the list
So it didn't exist,
And I had to live up to the rule.

No matter what work you would do
Of course there's no ideas in you,
But the man with a book
Has only to look
And he'll tell you everything true.

Perhaps you would try a new way
Of turning out more work per day,
Well, you might as well stop,
For they've got the whole crop
Of brains, in the office they say.

One day to their great surprise,
I worked till I opened their eyes,
For the pieces I made
Knocked their list in the shade,
And the systematizer likewise.

You wonder why I didn't stay,
In the shop just over the way,
And you think that I'm old
And got left in the cold,
Or couldn't earn enough pay?

But it happens that that wasn't it,
I made good all right, till I quit,
When the sheriff foreclosed,
And the system deposed,
For they hadn't made money, a bit.

And that's why I'm back in this place
Where little of system you'll trace,
But where it's the plan
To count you a man,
And not just a tool with a face.

Camden, N. J. R. E. MARKS.

Graduations for the Tailstock

In reply to Ethan Viall on page 321, graduations, or a vernier on the set-over of lathe tailstock would be of use in this way: It would be a great help in *taking the taper out of work.*

As to not being able to get results on

THE DUPLICATE WORK

duplicate work, I will give an example: In one place where I worked we used to get lots of 50 "posts" to turn, as shown in the cut, and as they had to be very accurate as to alinement of the threaded hole and the bearing at the opposite end, it was necessary to take a finish cut on the taper end before boring and threading. In order to do this a taper collar was made to fit, and the piece was then placed in the steady-rest and bored and threaded.

I did this job by cutting off stock as nearly even lengths as possible, centering with a punch just sufficient to start a center drill. The work was then taken to a small drill with a center post and the stop set for depth. The pieces were all centered on one end, then the holes cleaned and the stop set for the other end, and this end was marked, for they had to be of exact length. The marked end was put on the live center and all were squared up to a stop. Now it will

be seen that the distance from bottom to bottom of centers was the same in all the pieces regardless of whether one was deep or shallow, and if there was extra stock it would be on the end that was centered first, and squared up first.

After these posts were finish-turned the fit was so good that the taper collar could be slipped on with the hand so hard that it took a "lead" to drive it off.

No filing or fitting was done on these pieces and the time was reduced from 84 to 63 hours. With regard to jaws for steady-rests and back-rests for nice work, red fiber makes the best, it takes a high finish and does not mar the work.

Muscatine, Iowa. H. M.

Theory and Design of Friction Clutches

The article on friction clutches by Mr. Conway at page 254 interested me greatly, but after reading it the second time I began to wonder if there were not some loose ends. I have run up against a lot of this friction-clutch business, including some unpleasant experiences, as I think your readers will agree is likely. In the first place I take issue with Mr. Conway in his calling these things adhesion clutches. Of course, some of them are adhesive in their action when you want them to let go, but the fortunately designed clutch depends on friction.

Now cast-iron surfaces are probably used more than all other surfaces for the two types of clutches which he illustrates. Cast iron is peculiarly adapted to this purpose provided it is not too well fitted. This appears to be exactly the opposite of Mr. Conway's contention, but it is not quite so rank a statement as it looks to be at first sight. A friction clutch with metallic-surface contact must be lubricated. Cast iron is sufficiently porous so that it will carry a considerable amount of oil. This porosity or openness of grain is more in evidence in the case of a casting rough-turned than of one nicely polished. If the friction surfaces are left as they come from the lathe instead of being hand scraped to exact fits they will hold more oil. Since in use the oil is to a considerable extent squeezed from between the friction surfaces, it will be seen that for successful working there is need of an oil storage space somewhere and this the cast iron helps to give.

Surface Contacts

As for the close fitting of the parts to get actual metallic contact over a large percentage of the area, I think that Mr. Conway should have said that the only object is to enable a small clutch to carry the load of a large one. The frictional force tangent to the surface of the hub in a hub clutch is dependent on the pressure brought to bear on the friction to close it and on the coefficient of friction. If the surfaces are too small in area, then in the act of starting up the clutch slipping being necessary, abrasion will occur and the chances are in favor of the clutch refusing to let go. That is where the most prominent difficulty comes in that in tightening a friction clutch of any kind there is slipping until the friction changes from friction of motion with a very low coefficient to friction of rest with a comparatively high coefficient. I have used clutches where the coefficient of friction ran as high as 0.3. That is figuring on the basis of the power actually transmitted there must have been at least as high a coefficient as that. Now these clutches would not start up with full load on and do it right along. If started with no load and then the load applied they were all right.

While I have no data to prove it I feel from my experience that a clutch to start under load should not be figured on the basis of over 0.10 for the coefficient of friction. This will determine the diam-

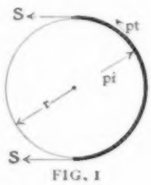


FIG. 1

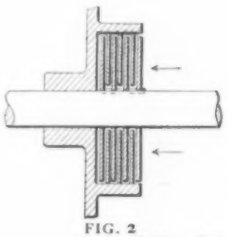


FIG. 2
American Machinist, N. Y.

DIAGRAMS RELATING TO THE DESIGN OF FRICTION CLUTCHES

eter; the width of the face can be figured on a basis of 15 square inches per horsepower if anyone likes to do it that way, though an even lower pressure per square inch is easily attainable without making the cost prohibitive.

In Fig. 1 I have a diagram showing the action of the forces on a hub clutch; $s\,s$ are the forces in the bolts on two opposite sides (one of them is enough in practice), p_i is the internal pressure per square inch and p_t the tangential force tending to drive the hub.

$$p_t = f\,p_i\,, \qquad (1)$$

where f is the coefficient of friction.

$$s = p_i\,r\,l, \qquad (2)$$

where r is the radius of the clutch hub and l is its length.
From (1) and (2),

$$p_t = \frac{f\,s}{r\,l}\,. \qquad (3)$$

The turning moment is

$$p_t\,(2\,\pi\,r\,l)\,r, \qquad (4)$$

or substituting (3)

$$f\,s\,2\,\pi\,r \qquad (5)$$

$$H.P. = \frac{2\,\pi\,r\,n\,(\textit{turning moment})}{396{,}000}, \qquad (6)$$

where n is revolutions per minute, and r is in inches, or

$$H.P. = \frac{4\,\pi^2\,n\,f\,s\,r}{396{,}000}. \qquad (7)$$

That is, the horsepower transmitted by the clutch is proportional to its speed, the coefficient of friction, the radius of the hub and the stress on the binding bolt. But p_i must not be so great that abrasion will occur which, since

$$p_i = \frac{s}{r\,l},$$

will depend on r and l both. Safe values of p_i depend on circumstances. If the load is not to be picked up by the clutch it may be high, possibly 1000 pounds per square inch. If it is to be picked up 150 pounds per square inch, which corresponds to Mr. Conway's results using a coefficient of friction of $\frac{1}{10}$, is safe. I have used as high as 200 with good results.

The Disk Clutch

Mr. Conway, however, omits any mention of the most efficient clutch of all, the disk clutch. The principle of this is illustrated in Fig. 2 where a series of disks are keyed loosely to the shaft and another series of disks are keyed loosely to the inside of the hub of the pulley. Convenient means are afforded to apply a force P to press these disks together lengthwise of the shaft. Pressure P acting on any one pair of surfaces in contact gives a frictional force of $f\,P$ acting theoretically at a distance from the center of the shaft of $2/3\,r$ and practically or about the mean radius of the disk. This frictional moment is multiplied by the number of contact surfaces between the disks, so that by having a sufficient number of disks it is possible to reduce the force P necessary to transmit a given power to a small amount, and consequently reduce the chances of heating.

I presume some college man will take exception to Mr. Conway's statement that there is no friction between surfaces which do not slip on each other, but since we all know what he means, what is the difference?

Boston, Mass. Con Wise.

A Gage for Ball Races

Referring to the gage published under this title on page 753 of our last volume, Part II, and again on page 236 of the current volume, we are informed that the gage shown is the subject of a British patent and that application for an American patent is on file.

High-speed Hydraulic Forging Presses

Throughout Europe steam hammers for forging gun parts, armor plate and general heavy forgings have been very largely replaced by hydraulic forging presses during the last decade. In this particular foreign practice has differed from American. However, the United Engineering and Foundry Company, of Pittsburg, Penn., has acquired, recently, the patents, drawings and rights for the United States, Canada and Mexico of the high-speed, steam-driven hydraulic forging presses developed and manufactured in Europe by Messrs. Davy Brothers, Ltd., of Sheffield, England.

This development is one of the most successful of the European types.

Two styles of these presses will be manufactured in the United States; the single-frame design shown by Fig. 1, and the four-column design shown by Fig. 2. The former will be built in sizes from 150 to 400 tons, inclusive; the latter from 300 to 12,000 tons, inclusive.

The peculiar advantage of the forging press over the steam hammer lies in the uniformity with which the piece being forged is worked throughout its entire mass. Hammer blows act upon the surfaces of the ingot, slab or block, and fail to condense and solidify the interior to the degree that can be obtained by direct pressure. This fact is shown by an examination, first, of the end of an ingot that has been hammered, and, second, of a similar ingot that has been pressed. The end of the former will show the edges overlapping or projecting beyond the center, indicating the surface drawing action of the hammer blows. On the contrary, the end of the latter will be bulged at the center showing that the pressure has acted upon both the interior and exterior of the mass.

The merit of the hydraulic-press forging process is well illustrated by German government specifications for steel forgings worked by rolls, hammer or press: "Forgings made from rolled or hammered steel must have the initial section at least eight times the finished section; those made from pressed steel need have an initial section only four times the finished section." In fact, the process is in such favor in Europe that it is stated that but very few steam hammers of over 1500 pounds capacity have been installed in England, Germany, France and Austria during the last ten years, and that many previously installed have been replaced by high-speed hydraulic presses. One cause of this widespread use has been the high-speed feature, in contrast to the slow speeds of operation of early hydraulic presses.

Elements of the Presses

Referring to Fig. 2, the elements of one of these presses are: The press itself shown at the left of the illustration and having a central ram actuated on its working stroke by water pressure and on the return stroke by steam pressure; a steam-driven hydraulic intensifier shown at the right of the illustration, and between these two elements a vertical, cylindrical tank with small water and air pumps attached—known as the "prefiller." The connecting piping can be plainly seen and needs no particular mention.

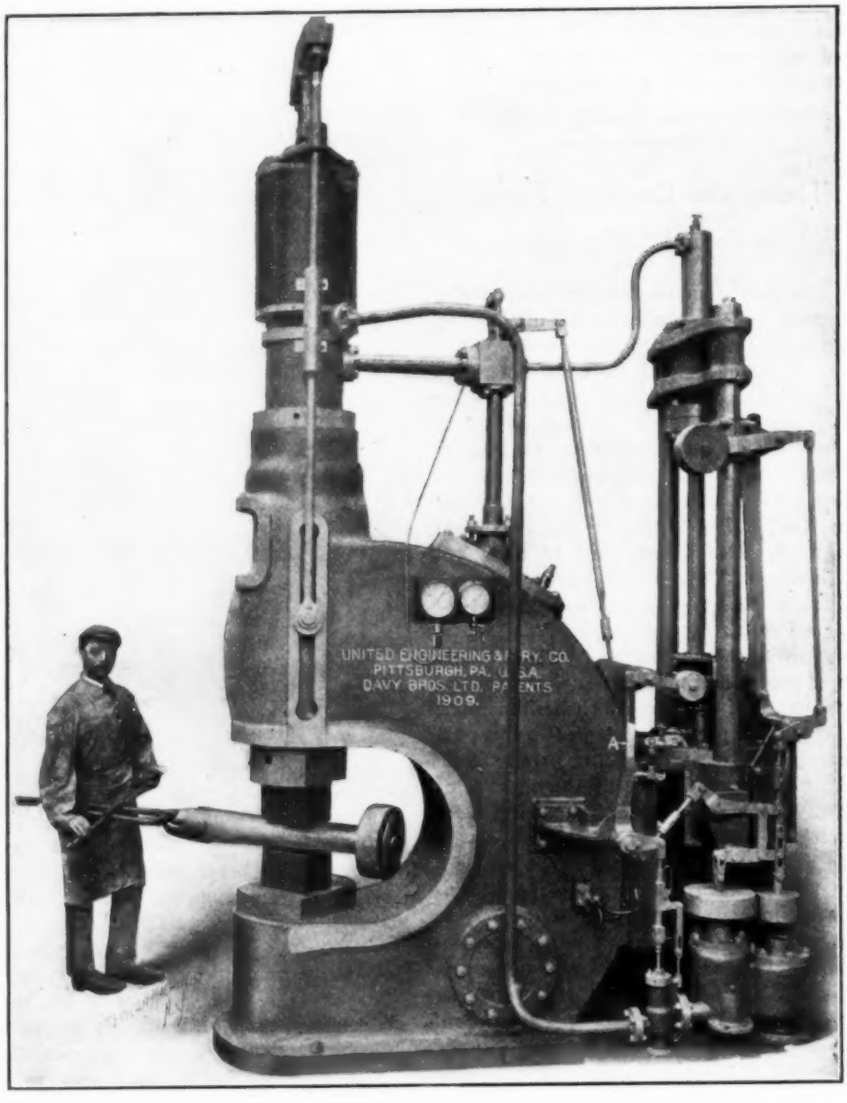


FIG. 1. HIGH-SPEED STEAM HYDRAULIC FORGING PRESS, SINGLE-FRAME TYPE

The important mechanical feature of this design is the control. The entire cycle of operations of the press is controlled by a *single* lever. See *A* of Figs. 1 and 2.

The Cycle of Operations

To describe the cycle of operations, let us begin with the forging dies together as shown in Fig. 2. The operator first pulls the *single* operating lever *A* toward him. This admits steam to the return cylinders *B B* and the crosshead *C* with the upper die lifted to the desired hight allowing the forging to enter between the dies. This operation also forces water from the main ram cylinder *D*, or press cylinder, into the small intensifier cylinder *E* until the plunger of the latter, together with the attached intensifier steam piston, is in its lowest position. Any surplus water remaining after the intensifier system is filled enters the prefiller *G*. The check valve of the prefiller *H* is opened by the first movement of the *single* operating lever.

If the crosshead has been lifted too high for the size of the forging to be operated upon, the forward motion of the *single* operating lever, which now takes place, exhausts the steam from beneath the return pistons and the upper die descends upon the forging. At the same time water from the prefiller, under an elastic air pressure of about 60 pounds gage, fills any space in the system between the intensifier ram and the main ram, that may exist after the descent of the press ram. The machine is now ready to exert pressure. The operating lever is now thrown forward of its central position; this places the return cylinders under constant steam

pressure and makes a "steam spring" for the upper die. A little more forward motion of the operating lever opens the steam inlet valve *I* admitting steam to the bottom of the intensifier steam cylinder. Its piston ascends forcing upward the intensifier ram, and this, in turn, forces water under high pressure into the press cylinder. This action pushes downward the press ram and performs the operation of forging.

A backward pull of the operating lever *M* carried upon a bracket from the intensifier ram. This controls steam cut-off and thus the stroke of the intensifier piston. In other words, the crosshead of the press follows the motions of the operator's hand; moving rapidly or slowly, to a considerable hight above the forging or only a short distance, as his hand pushes the lever rapidly or slowly or to a greater or lesser distance past the central point of the lever's stroke. Small machines can be operated as rapidly as 120 strokes per minute; larger ones as rapidly as the forging can be manipulated.

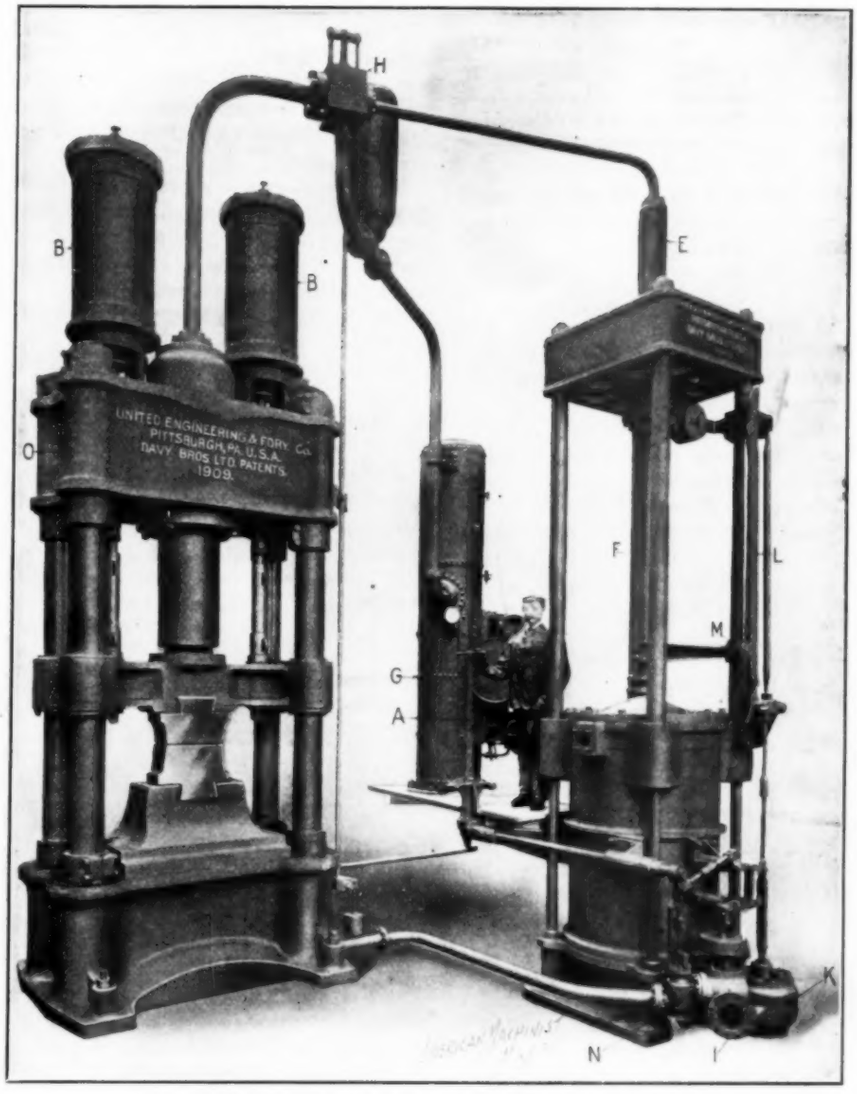


FIG. 2. HIGH-SPEED STEAM HYDRAULIC FORGING PRESS—FOUR COLUMN TYPE WITH SINGLE CYLINDERS

exhausts the steam from the intensifier cylinder through the exhaust valve *K*, lifts the crosshead and prepares the machine for the next working stroke; a forward push of this same single lever initiates this working stroke, and so on.

The Safety Device

To prevent over-travel of any of the parts, and thus possible damage, an ingenious safety device is provided. The position of the single operating lever determines the relative angularity of the flat bar *L*, Fig. 2, which is engaged by a roller

The carefully worked out system of levers and connecting rods between the single controlling lever and the various valves is shown clearly in the illustration. All of these valves so operated are steam valves with the exception of the check valve *H* in the prefiller line; thus the greatest element of trouble in hydraulic systems, valves under high pressure, is done away with. The only packings to care for in high-pressure system are: one around the main ram and a second around the intensifier ram.

In Fig. 2, behind the operator, is a small air compressor for charging the prefiller with air. On the line of piping between the prefiller and the press is an air chamber. The steam-exhaust valve for the return cylinders is indicated at *N*.

Details of Construction

Referring again to Fig. 2 the base of the press is a heavy steel casting forming an anvil for the lower die and receiving four tie rods. These rods are of steel with buttress threads for attaching the nuts. The crosshead is of steel; the plunger, or ram, of chilled cast iron. At this point is an interesting detail of construction. Projecting upward from the crosshead is a long pintle that extends nearly to the upward end of the plunger. The plunger is a detached piece and bears upon the end of the pintle through a spherical seat of hardened steel. A screw fastens the two parts together and the opening thus formed around the screw head—or better, cover plate—is packed with U-packing to prevent leakage. The value of this construction is in connection with eccentric pressures. If a forging is placed between the dies so that the pressure is not central with the length of the crosshead there is a tendency to set up a cramping effect in the moving parts of the press. However, the long pintle projecting upward from the crosshead and the plunger connected thereto through a spherical seat overcome this cramping action, and insure that all parts of the press move and act as a unit.

The entablature *O* is a steel casting; the return steam cylinders are of cast iron. The intensifier steam cylinders are of cast iron, the tie rods are of steel and the ram of nickel steel, to gain additional stiffness because of its length. Referring to Fig. 2, it will be noticed that some of the gland bolts of the intensifier ram are extended. When it becomes necessary to repack this joint, the gland flange can be lowered at the same time being held by nuts on these extended bolts; the ram can be dropped to its lowest position and there is then ample room to remove the old packing and insert new, working through the space between the intensifier head and the lowered flange. Similarly, by removing the die from the crosshead, the main ram of the press can be dropped to such a position that its joint can be packed without any other disassembling of the machine.

Referring to Fig. 1, the corresponding parts of the single-frame press are easily recognized by turning to the preceding description of the four-column press, with the exception of the prefiller. In the single-frame type the steel casting forming the frame is cored out and the space thus formed is the prefiller chamber. It may be noticed that no air compressor shows in Fig. 1; as this air compressor is in the nature of an auxiliary, so far as this style of press is concerned, it can be placed in any

desirable location, or the air which is needed for the prefiller can be obtained from a regular source of supply in the plant.

In regard to erecting, no massive, expensive foundations are necessary. All that is required is a sufficient support to sustain the weight. Noise and vibration are eliminated, and it is claimed that the steam consumption is only about one-half of that required for a steam hammer for the same work. The steam pressure for which these machines are regularly designed is 150 pounds gage.

The largest sizes of these presses, such as are used for armor plate and similar work, are provided with two main rams instead of one as shown in Fig. 2. Again, these larger sizes are provided with a track and a hydraulic shifting device for the lower dies. By their use the lower dies can be removed and replaced in a very short space of time, permitting the use of two or more different dies on the same forging and without the necessity of reheating.

Work for Which Adapted

These high-speed hydraulic presses are adapted for all kinds of hot or cold forging, punching and shearing. In forging they will work close to a shoulder, or better, forge a square shoulder, as shown by the piston forging between the dies in Fig. 1. In forging crank-shaft forgings the shoulders are left square and the surplus metal opposite the section left for the pin is punched out. These machines are also peculiarly adapted in the smaller sizes for making drop forgings in finished dies.

The Newer British High-speed Steels—Addition

In our last issue, at page 560, an article appeared under the above heading by our English editor, but unfortunately the following table and particulars, intended as part of the article, but sent by separate post, did not reach us until after the forms for the last issue were closed and printing. The additional material is, therefore, published herewith as a part of the former article.

Table 3 gives results of tests made on March 24 by Thomas Nash & Sons, at their Sheffield testing works, on twist drills 15/16 inch in diameter running at 435 revolutions per minute; that is, with a peripheral speed of about 106 feet a minute, and a feed of 6½ inches a minute. The metal cut is described as medium hard cast iron. Holes were drilled 3 inches deep and each test was run until the drill was done up. Assuming that fair samples were taken, the great advantage possessed by the newer high-speed steel is demonstrated by the figures and it is not necessary to add more than that the steels for the first two drills were of the best quality used in Great Britain. In fact the material in the second test was the same as that in test No. 9, of Table 1 and test No. 3 of Table 2.

	Material.	How Hardened.	Total Depth of Drill.	Condition of Drill.
1	Ordinary H.S. steel	....	4½ in.	Done up.
2	Ordinary H.S. steel	....	3 in.	Done up.
3	Triumph Superb.	Air	32½ in.	Done up.
4	Triumph Superb.	Oil	33 in.	Done up.
5	Triumph Superb.	Water	47 in.	Done up.

TABLE III. TESTS OF TWIST DRILLS.

Design of Overhanging Driving Pulleys

By J. H. Jounson

An overhanging driving pulley is a thing to be avoided whenever possible, but circumstances may arise in which its use must be perforce resorted to. As often as not the design of bearing for such a pulley is as shown in Fig. 1.

The pulley *A* is secured by the set screw *C* to the driving shaft *B* running in the bushing *E* carried in the bracket *D*. The collar *F*, which is taper-pinned to the shaft prevents end play. This design is bad, as the bush *E* wears bell-mouthed at the pulley end and the bending effect on the shaft due to the pull of the belt on the pulley increases as the wear on the bush increases. This gives combined bending and torsion on the shaft in transmitting the drive.

In the improved design, Fig. 2, these difficulties are overcome in the following manner: Following the same lettering it will be seen that the bush is prolonged and that the pulley runs upon its periphery. The drive is transmitted through the collar *G*, which is secured to the pulley, and also taper-pinned to the shaft. The collar *F* is the same as in Fig. 1. Thus the shaft is subject to torsion alone, or practically so.

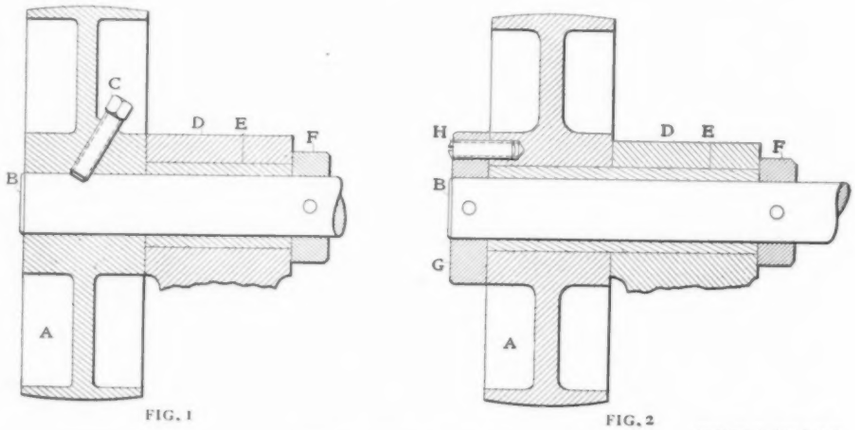


FIG. 1 FIG. 2

American Machinist, N. Y.

OVERHANGING PULLEY DESIGN

The Chief Engineer and the Ventriloquist

The following is a brief account of the terrible fate of a practical joker:

Sunday—Chief engineer's log book notes visit of a stranger. A severe squeak in engine No. 1 was remedied by a liberal application of oil.

Monday—Report shows that stranger again called and stayed some time, during which engine No. 2 developed an annoying squeak.

Tuesday—Stranger proves to be brother-in-law of the assistant engineer. Called again today, but could not pay much attention to him, as engine No. 3 had to be oiled to stop a severe squeak.

Wednesday—Everything O. K. No callers and no squeak.

Thursday—Stranger called. Engine No. 1 had to have all the lubricators speeded up in order to stop squeaking. Stranger seems a hoodoo.

Friday—That confounded stranger called again, and I used up three pints of oil to stop the noise. I wonder why he and the squeaks seem to call at the same time. Looks queer.

Saturday—Last night assistant engineer told me his brother-in-law was a ventriloquist. I guess I was pretty easy.

Saturday afternoon—Stranger called. Squeak at last definitely located. Two quarts of dirty oil were poured upon the squeak. The cause of the squeak walked out of the engine room to buy a new suit of clothes. He said he would fix me. That's what they all say.

It is stated that the oil used on railways in the United States as fuel amounted in 1907 to 18,855,691 barrels, and it is estimated that 13,593 miles of railway were operated by oil-fired locomotives.

AMERICAN MACHINIST

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Our circulation for March, 1909, *was (weekly, monthly and European)* 91,250.

April 1	34,750
April 8	19,250
April 15	19,250

This paper reaches 34,750 *separate readers each month and* 19,250 *each week.*

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

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Different Views of Publishing Shop Information

In the work of securing the right kind of information for a periodical of this kind, information that shall be a real help to anyone interested in mechanical lines, many different phases of human character are encountered. Most of the manufacturers of machines and tools used in the building of other tools have come to see that the best guarantee of accuracy they can produce, is to show their carefulness in manufacture, as illustrated by the tools and methods used in making and testing their product. This leads the more progressive to show freely their ways of doing the work and to welcome any suggestion that will make it even better.

Others, who do not make articles that are likely to be largely used by readers of this paper, are also adopting the liberal plan of adding to the general fund of mechanical knowledge in this way. They also consider that if their methods are of enough general interest to be published, they are justified in referring to it as an evidence of good workmanship.

Then there is the policy which is perfectly willing to show the outside of the shop or a general view of the interior which shows the usual array of lathes, planers, etc., and which might answer for a dozen other shops of the same general design, but of not allowing a single detail which gives an idea or suggestion to be printed. This is all the more difficult to understand because they are usually very liberal in taking visitors through the plant, which means that those directly interested in the same line cannot help knowing their methods if they tried—and they never do.

This policy labors under the idea that direct injury would result from the publication of methods used, but this we believe is usually an erroneous idea as those who are vitally interested, probably know all about it already. To others, it simply broadens their field of general knowledge and contains suggestions that may help in other ways as by being applied to other classes of machinery which can do no possible harm to the originators.

Then there is the narrower policy, where it is freely admitted that no possible harm can be done in the way of assisting competition or injuring trade but which refuses any information because it is unable to see where a direct financial benefit will result.

This is sharply contracted by the policy which says "We secure many valuable ideas from the AMERICAN MACHINIST. Someone originated them for his own use but gave up the information that it might help me and others. If everyone tried to keep all their ideas to themselves we wouldn't know as much as we do now, so I'm glad to help along when I can."

This, it seems to us, is the broad way of looking at the question. The advance in American machine-shop methods has been largely due to the interchange of ideas that has prevailed. We do not ask anyone to let us publish information which would be a detriment to them in any way and of that, of course, they must be the judge. We believe, however, that many mistakes are made in refusing publication to methods and machines in the belief that they will be copied by competitors. As a rule the methods of one manufacturer are known by the others in that line in spite of much self-delusion to the contrary.

And there is another phase of the question which is apt to be overlooked. We have known many cases where credit for a device or machine or method has been given to the wrong party simply because they were the first to publish it to the world at large. The real originators of the device naturally feel that this is unfair and yet the fault is really theirs as they hid their light under a bushel and refused to have it published, or if published, to allow enough detail to be given to impress it on the minds of the mechanical public.

We believe there are very few things that would really harm the originators if made known and that, unless it does harm, it should be made known for the general good.

Proposed Boston Branch of the American Society of Mechanical Engineers

A meeting of mechanical engineers living in and near Boston is called for Friday evening, April 16, in the auditorium of the Edison Electric Illuminating Company, 39 Boylston street, for the purpose of discussing a plan for holding in Boston meetings of the American Society of Mechanical Engineers for the reading and discussion of papers, similar to those held in New York.

The plan is similar to that which obtains with other national societies, and it has been suggested as the most effective method of enabling the local members of the society and others to share in the activities of the national society.

American shipbuilding during the fiscal year ending June, 1908, surpassed all previous records. The total number of vessels built during that period was 1457, with a gross tonnage of 614,216. It will be a matter of surprise to most Americans that the United States ranks only behind England in the aggregate documented merchant shipping, with 25,425 vessels, gross tonnage 7,365,445, as against the 11,563 vessels, gross tonnage 18,709,537, of Great Britain. Most of the large shipping of this country is carried on the Great Lakes or in coastwise trade and the seven seas see but little of the American flag.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

A German Hobbing Machine

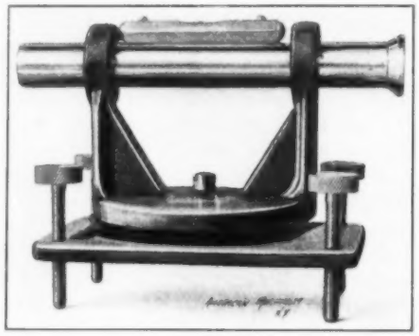
Gear hobbing has become too well known to need any attention being called to the advantages of continuous cutting and indexing or the use of one hob for each pitch. Ordinary single cutters can be used if desired, but in that case an indexing attachment is necessary and is furnished as an extra, as very few require it. This is one of the machines that has been successful in Germany and is being distributed in this country by Schuchardt & Schütte, 90 West street, New York. Fig. 1 shows the method of supporting a large gear, while in Fig. 2 is shown the arbor support to eliminate all spring and vibration when a long string of blanks are being cut or the work is extremely severe.

This machine is built in nine sizes, the smallest, No. 00, cutting 7 inches outside diameter, 6-inch face and up to 10 diametral pitch, while the largest cuts up to 120 inches diameter, 18-inch face and ¾ diametral pitch. The first weighs 800 pounds and the last 37,000 pounds. All the machines can be used to cut plain, spur, helical or spiral and worm gears as desired, and the growing use of spiral gears opens a large field in the line of gear cutting.

A substantial guard is provided for all the gears at the side of the machine, thoroughly protecting the operator and at the same time affording easy access for changing the gears for cutting spiral gears.

A Handy Shop Transit

Although the full-fledged civil engineer would consider this a rather crude instrument, it has all the essentials of the transit that are needed in laying out a large variety of work. It consists of a base with four leveling screws, carrying a frame that holds the tall telescope and allows it to be swung around to any angle. Top of the telescope is a level for setting up the instrument correctly, no matter whether it is placed on a pier, a bench, or a step-ladder.



A HANDY SHOP TRANSIT

Many uses will be found for this in almost any shop where shafting is to be run or leveled up, as by setting the transit level and sighting on targets held at any convenient distance below the shaft it is easy to determine if it is out of line and how much. The telescope has cross-hairs so that accurate sighting can easily be done and the whole thing is small enough to be convenient in every way. It is made by H. W. Brown, 63 Canal street, Waterbury, Conn.

A New Brazing Compound

"Universal Fluxine," a brazing compound being made by the Universal Fluxine Company, Urbana, Ohio, has recently been put on the market to aid in the fusing of cast iron and other metals. The pieces should be fastened together in any convenient manner, heated enough to insure the free flowing of the fluxine and spelter used in the regular way. The makers recommend its use for brazing high-speed steel cutters to soft-steel bodies, as it

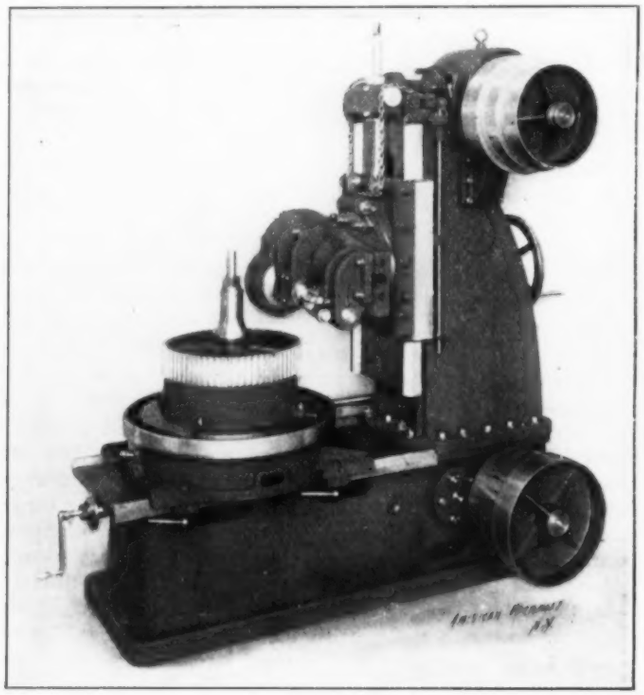


FIG. 1. HOBBING A LARGE GEAR

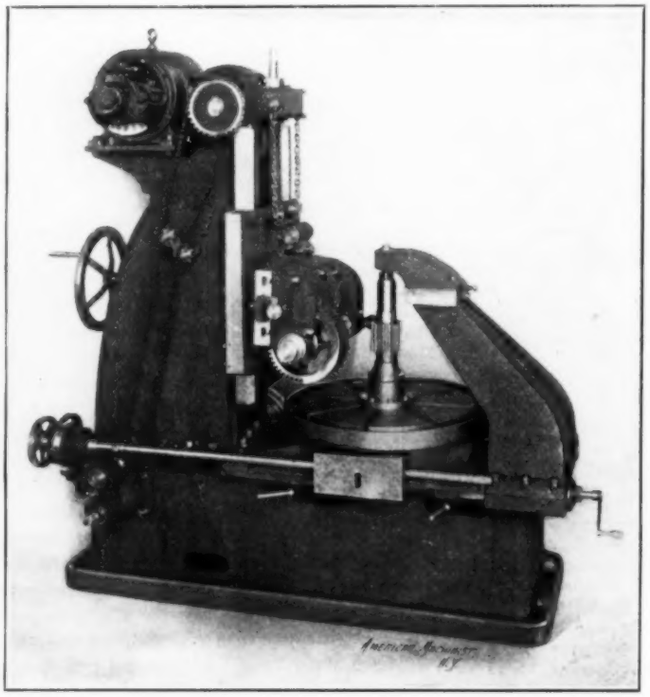


FIG. 2. USING THE SPINDLE SUPPORT

does not injure the surface of the steel in any way. After brazing, a 20-per cent. solution of sulphuric acid used as a pickle will remove the flux from the work and save files. Full directions are given and appear to be simple enough to be used in any shop.

Tube or Spindle Drilling Machines

Those who have attempted deep-hole drilling with ordinary shop tools know some of the difficulties that attend it and will appreciate the machines shown herewith, as well as the experience of the builders in this connection. The machine has two spindles, is motor driven, and is provided with all the modern appliances in this line. Although listed to carry a 3-inch drill, they will handle holes up to 4 inches under favorable conditions. The work to be drilled is revolved by the chuck at the head of the machine, the outer end of the work being run in a bushing in the central heads, and these also carry a bushing for the drill so that it is always supported at the start and makes it easy to enter.

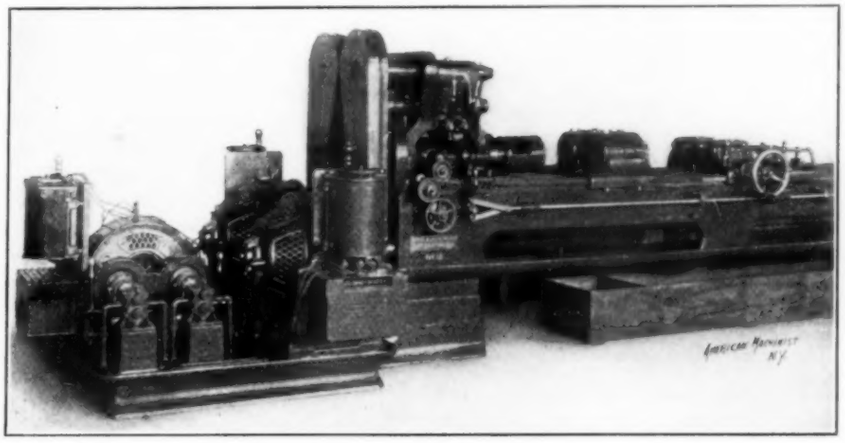


FIG. 1. DOUBLE-HEAD TUBE-BORING MACHINE

Special drills are used, as can be seen in Figs. 2 and 3, having but one lip, and also having an oil groove to carry the oil under heavy pressure clear to the point of the drill. This keeps the drill cool and forces out the chips as they are cut. The work is run at a high speed and the absence of the center or noncutting web in the drill obviates all tendency to run in any way except a straight line.

The heads are driven independently so that either or both can be used as desired. The central supports can be adjusted for the work in hand, and the hood on each conveys the oil to the pan below. From here it goes to the pumps which are at the head end of each machine, one being provided for each spindle. The carriages have both hand and power feed, have automatic knock-offs, and the rate of power feed can be varied at will. The feed drive is controlled by the working spindles, and so constructed that an abnormal resistance cuts out the feed and prevents breakage of drills.

The drills have stepped cutting lips, as shown in Figs. 2 and 3, to break up the chips and make it easier to remove them by oil pressure. These can be readily ground on the little machine shown in Fig. 4, the fixture having a cam-controlled movement that keeps the face of the drill against the wheel and grinds it at the correct angle for securing the best results. These are all made by the Pratt & Whitney Company, Hartford, Conn., who have had years of experience along this line of work.

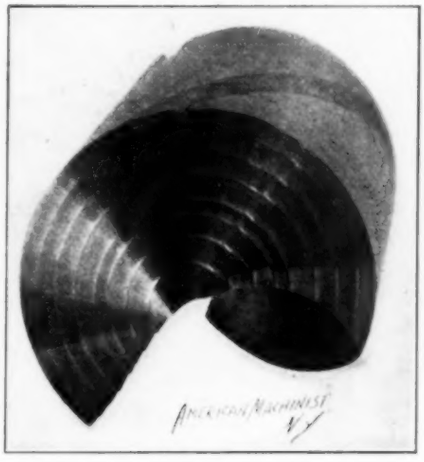


FIG. 2. END OF DRILL SHOWING OIL TUBE

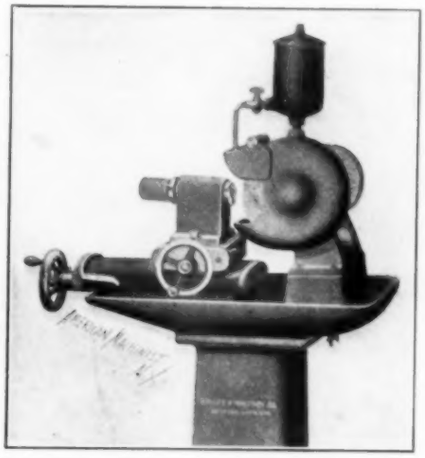


FIG. 4. GUN DRILL GRINDER

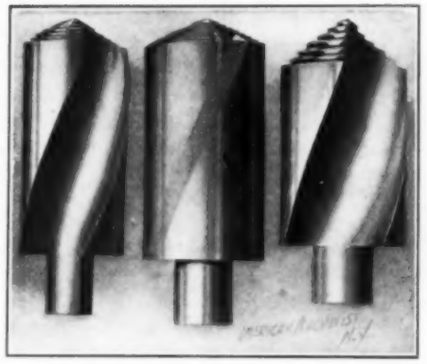
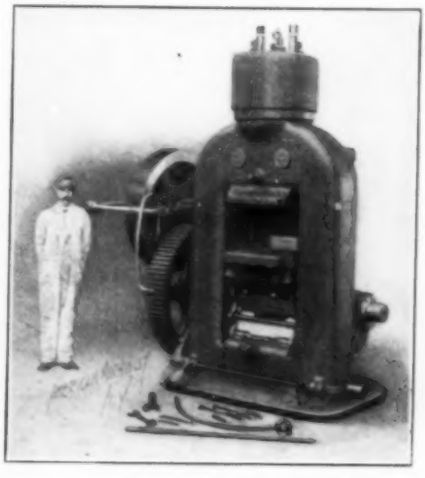


FIG. 3. DEEP DRILLING-TOOL POINTS

Press for Drawing and Forming Shallow Work

The press shown in the accompanying illustration was recently built by the Ferracute Machine Company, of Bridgeton, N. J., the special work for which it is intended being the drawing and forming of shallow work up to 20 inches diameter and 1 inch deep in 1/16-inch sheet steel. The forming operation requires considerable pressure as the heavy sheet metal has to flow or be "coined," which explains why a press of the coining type is used.

The distance between columns is wider than in an ordinary coining press, but notwithstanding this fact, the machine is smaller and more compact than the conventional drawing press in which work of this nature is usually performed. The ram is forced upward by powerful steel toggles at the back of the press and has a stroke of 2 inches. The pressure exerted by the ram when it reaches the top of its stroke is 450 tons.



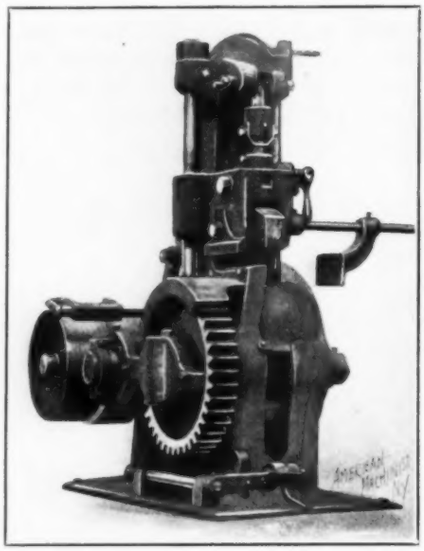
PRESS FOR DRAWING AND FORMING SHALLOW WORK

An important feature is the spring-holding and clamping attachment, shown on the top of the press. A number of heavy steel springs incased therein exert a total pressure of 60 tons on a steel spindle or stem that projects centrally down through the head. This stem (corresponding to the blank holder of a drawing press) may have as much vertical motion as the ram, but as shown in the engraving, is adjusted for 1 inch motion. An adjusting wedge is interposed between the head and the upper part of the frame, the head being adjusted vertically by means of the bolt shown just above it which moves the wedge in and out. An effective friction clutch connects the flywheel to the shaft when the treadle is depressed, the clutch being automatically disconnected at the end of the stroke unless the treadle is locked down. The columns are solid, each having a sectional measurement of 13x14 inches. The press occupies a floor space of 108x54 inches, is 110 inches high and weighs 22,500 pounds.

Combined Punch and Shear

This is somewhat different from the usual combination inasmuch as the punch is above the shear and also is in the form of a removable yoke which is made for one size only. By this means the punch and die are always kept in alinement as in a subpress, which has its advantages. The change from one yoke to another is easily and quickly made, taking less time than the setting of a punch and die in the usual way.

Both shear and punch have been placed at a comfortable working hight from the floor. On light work the punch or shear is driven directly by the gearing, but for heavy work the power is applied by a ratchet which applies increased power to the tool being used. The machine shown is 3 feet 7 inches high, occupies 12x25 inches of floor space and weighs 800 pounds. It will punch a 5/8-inch hole in 1/2-inch iron or a 1 1/4-inch hole in 3/8-inch iron, and shear a 5/8-inch stock 6 inches wide. It is made by the Jannell Machine Company, Rumford, Me.



COMBINED PUNCH AND SHEAR

Two German Boiler Making Tools

These show two tools of German design for use in boiler making, Fig. 1 for cutting manholes, either round or oblong, and Fig. 2 for trimming up the boiler heads. The first is an ingenious arrangement in which the cutting-head spindle works in a quill carrying the large gear, while the small gear on the head itself travels around the large, stationary gear and operates a crank beneath which moves the tool block back and forth in the slide and produces the oval shape desired. This makes a very neat device and one that is effective without being complicated.

The other machine is simply a large wall-type vertical facing machine, with two arms and a center spindle. Both are built by Wilh. Scharmann, Rheydt, Germany.

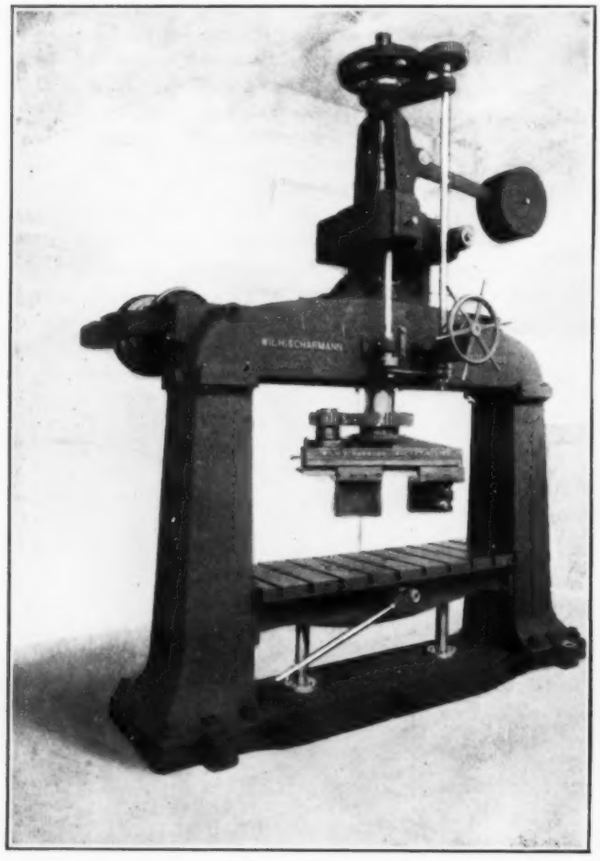


FIG. 1. FOR BORING MANHOLES

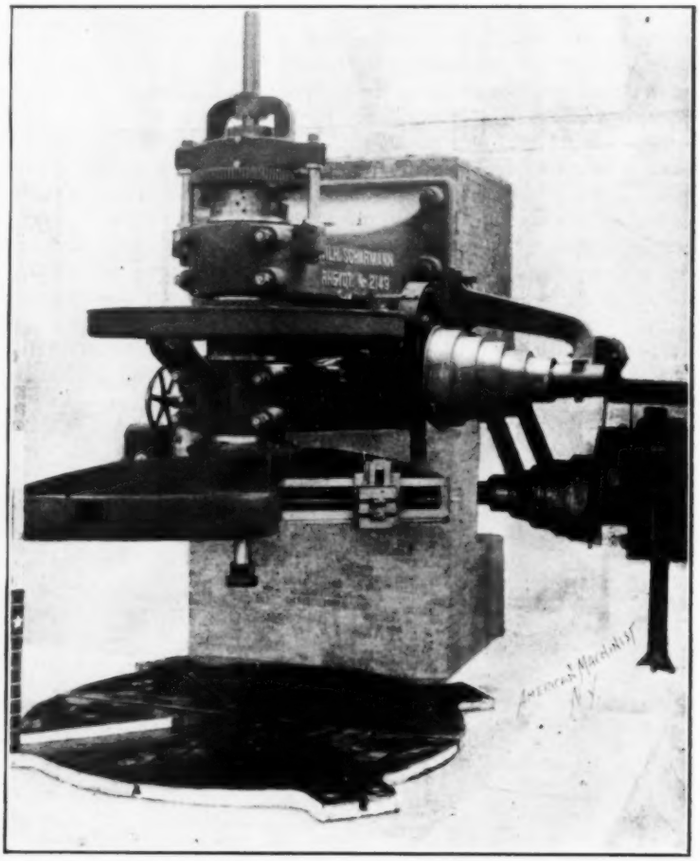


FIG. 2. FOR TRIMMING BORING HEADS

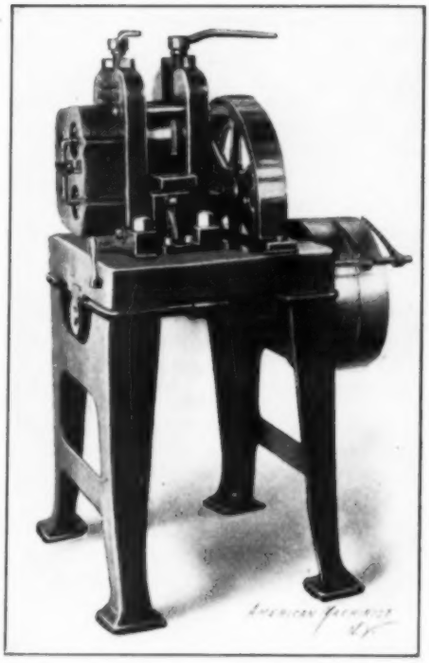
Steam Hammers with Integral Anvil

Among the many types of power hammers built at the Bement works of the Niles-Bement-Pond Company is the special 8000-pound double-frame steam hammer, shown herewith. This differs from the usual large steam hammer in having the anvil resting on the hammer base instead of being entirely separate as is usually the case. The base carries the anvil in the center and to this is fastened each leg of the double frame by the spring-mounted bolts shown. The frame is lipped over on each side of the base, and these eight heavy springs allow for any vertical movement due to the blow of the hammer. In addition, the two frames are tied together by the three rods so as to withstand any shocks that may be put on them.

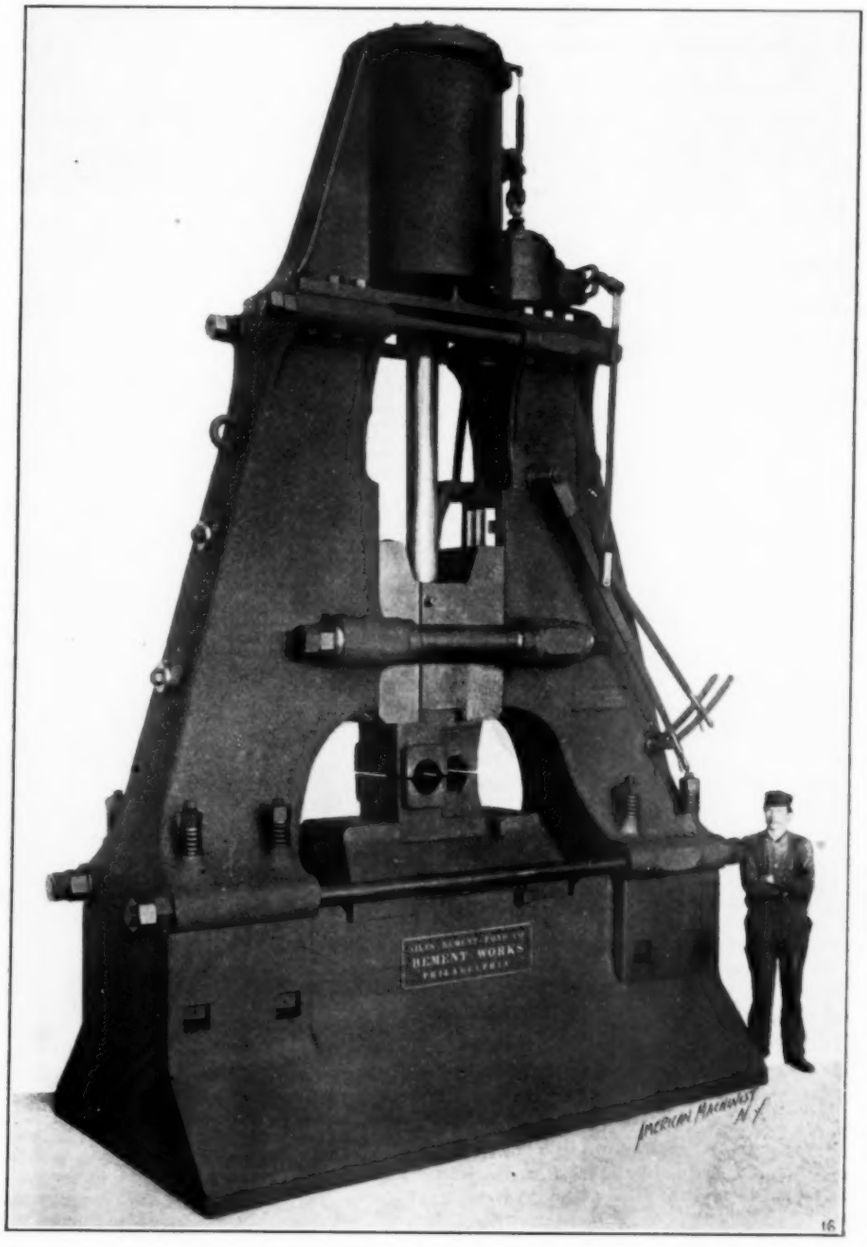
They also make single-frame hammers, steam drop hammers, steel tilting hammers and the regular board-drop hammer with a belt drive.

Water Cooled Rolling Mill

This is one of a line of tools made by the Atlas Machine Company, Waterbury, Conn., for the special handling of fine sheet metals and wire. It is a small rolling mill for very accurate work, has rolls 6 inches in diameter by 2½-inch face, and cools the rolls by passing water through them as shown by the piping. This is a good illustration of the heat generated by the work performed in rolling metal, as most of the heat comes from the rolls themselves and very little from the bearings, as they turn rather slowly.



WATER COOLED ROLLING MILL



SPECIAL 8000-POUND HAMMER FOR AXLE FORGING

High-speed Radial Drill—Erratum

In our description of this tool at page 546, it was stated that there were a pair of bevel gears in the driving mechanism at the base of the column. The makers, the American Tool Works Company, Cincinnati, Ohio, call our attention to the fact that there are no gears in the drive of this machine from the countershaft through to the spindle, the drive being entirely by belt.

G. Charles Connor

G. Charles Conner, manager of the Philadelphia office of the Sprague Electric Company for the past six years, died on March 27, after a brief illness. Mr. Conner had become a well known figure in the electrical business, and his untimely death is a matter of considerable sorrow among a large circle of business friends and associates.

The operating cost of the Brooklyn bridge is found to be as high as $360,000 per year, according to an investigation made. This figure is the average of 10 years' maintenance and operating costs. In 1907 the cost slightly exceeded $400,000. The city's revenue from the bridge has exceeded $400,000 per year during the same period, and has always been larger than the cost until 1907, when there was a deficit of $3250.

Personals*

J. R. Detweiler has become district manager of the Buckeye Engine Company with headquarters at Wichita, Kansas.

Joseph L. Pitkin has entered the employ of A. Klipstein & Co. as Southern representative, with headquarters at Atlanta, Georgia.

Ervin G. Bailey, until recently connected with the coal department of A. D. Little, has become mechanical engineer with the Fuel Testing Company, Boston, Mass.

William N. Stevens, engineer, with Fred Bacon & Co., has become vice-president of the Conveying Machinery Company, New York City.

F. Valtier, formerly superintendent of the National Elevator Company, is now associated with the Springfield Elevator and Pump Company, Hartford, Conn., in a similar capacity.

George O. Hodge has joined the engineering staff of the Bristol Engineering Corporation. Mr. Hodge was formerly connected with the New York Car and Truck Company.

Harris R. Greene, who has been associated with the Parsons Manufacturing Company, recently joined the Alberger Condenser Company, New York City, and will act as sales engineer.

Louis Bendit, formerly connected with the Weber Gas Engine Company, has recently been appointed by the Buckeye Engine Company, Salem, Ohio, to take charge of their Kansas City office.

J. F. Richman, general foreman of the Maxwell-Briscoe Motor Company's New Castle (Ind.) plants, has resigned to accept the position of superintendent of the Hudson Motor Car Company, Detroit, Mich.

Dr. N. Clifford Ricker, head of the department of agriculture of the University of Illinois, gave an interesting paper on the "Investigation of Base Plates" before the American Society for the Advancement of Science, at a meeting recently held in Baltimore, Maryland.

Edwin C. Thurston, formerly in the designing department of the Gould & Eberhardt Company, has associated himself with J. C. Blair, expert toolmaker, and will conduct a general business for designing and building small, special machinery at Newark, N. J. Prior to his last connection Mr. Thurston was with the Brown & Sharpe Manufacturing Company for more than 10 years.

*Items for this column are solicited.

Fixture for Milling Crossheads

By H. L. Dean

The fixture shown in the accompanying cuts is a rig that has given excellent results in the milling of engine crossheads of the form shown, the surfaces to be milled being marked *f*. *X* is a half plan

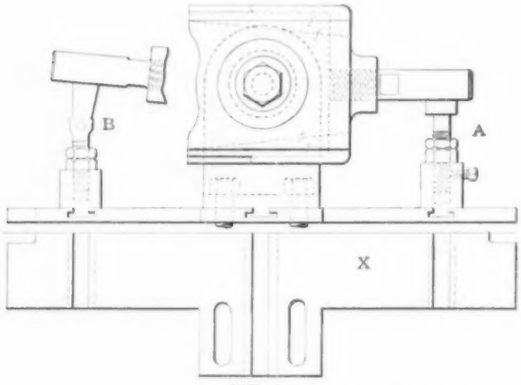


FIG. 1

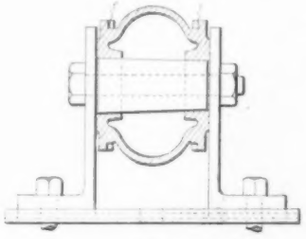


FIG. 2

American Machinist, N. Y.

A FIXTURE FOR MILLING CROSSHEADS

view of the base piece of the fixture which is rigidly clamped to the table of the milling machine and which is slotted for the angle plates shown in Fig. 2. These are a good fit in the T-slots, but may be adjusted transversely to suit the work. The front angle plate is left off in Fig. 1 for clearness. A taper pin slightly shorter than the width of the crosshead is placed in the body and through holes in the angle plates and pin a close-fitting bolt is passed to draw the parts together.

In operation the mandrel is screwed into the hole for the piston rod and the jack *A* placed beneath it to level the work when the two flat surfaces may be finished. The jack is removed, placed on the other end of the base, the crosshead and mandrel swung over and the other two flat surfaces machined. The arbor and cutters of the milling machine are now replaced by another set and the crosshead set at the required taper by the jack *B*. The tapered surfaces are now machined, when the jack is changed and the crosshead swung back to accommodate the opposite side. It is thus seen that the eight surfaces to be finished are completed in four cuts and that the crosshead is not removed from the fixture until finished. Such a procedure gives excellent results on large lots of crossheads, reduces to a minimum the time required for fitting the shoes and insures interchangeable parts.

The fixture may be made to accommodate a wide range of sizes, the only extra parts needed being the taper pins and the mandrels for the different types and sizes. By grinding the outer ends of all the mandrels to exactly the same diameter the setting of the jacks need never be disturbed after the first adjustment.

Forthcoming Meetings

The Foundry and Manufacturers' Supply Association, convention, Cincinnati, Ohio, week of May 17.

American Society Mechanical Engineers, semi-annual meeting, Washington, D. C., May 4-7. Calvin W. Rice, secretary, 29 West Thirty-ninth street, New York City.

American Foundrymen's Association convention, Cincinnati, Ohio, May 18-20, headquarters Hotel Sinton. Richard Moldenke, secretary, Watchung, N. J.

Railway Master Mechanics Association, annual convention, June 16-18, Atlantic City, N. J. Jos. W. Taylor, secretary, Old Colony building, Chicago, Ill.

Master Car Builders Association, annual convention, June 21-23, Atlantic City, N. J. Jos W. Taylor, secretary, Old Colony building, Chicago, Ill.

National Machine Tool Builders' Association, spring meeting, May 25-26, Milwaukee, Wis., headquarters, Plankington house. P. E. Montanus, secretary, Springfield, Ohio.

American Society of Testing Materials, annual meeting, June 29, July, Atlantic City, N. J. Edgar Marburg, secretary, University of Pennsylvania, Philadelphia, Penn.

American Supply and Machinery Manufacturers Association, joint convention with Southern Supply and Machinery Manufacturers Association, Chattanooga, Tenn., May 5, 6, 7; headquarters, Hotel Patten.

National Supply and Machinery Dealers Association and American Supply and Machinery Manufacturers Association, joint convention, Pittsburg, Penn., May 12-13-14, headquarters Fort Pitt hotel. A. T. Anderson, secretary, Wade building, Cleveland, Ohio.

American Hardware Manufacturers Association, joint convention with Northern Hardware Jobbers Association, Pittsburg, Penn., June 9-11, headquarters Hotel Schenley. F. D. Mitchell, secretary, 309 Broadway, New York City.

Business Items

Among the recent orders received by Tate, Jones & Co., Inc., general offices, Pittsburg, Penn., is an extensive one from the Erie Forge Company, Erie, Penn., for fuel oil burning equipment for use in open hearth furnaces.

The Carpenter Steel Company announces the appointment of Russell Dale, formerly sales manager of the Celfor Tool Company, as Chicago representative, with headquarters in the Commercial National Bank building, Chicago, Ill.

Cleveland Automatic Machine Company reports that its business is exceptionally good. The orders received in February and March have been nearly normal. The business has come almost entirely from this country—all sections of it east of the Mississippi—very little having been received from abroad. This company has given positions to a number of additional machinists and toolmakers in the past six years and states that prospects for the future are very bright.

Business Opportunities

The E. Q. Smith Chair Company, Evansville, Ind., will erect new plant.

The Dayton (Ohio) Motor Car Company will erect a new six-story factory.

B. D. Tillinghast, McDonald, Penn., will erect a new machine shop and foundry.

The Canton (Ohio) Enameling Company will build a new plant to cost $40,000.

The New Haven (Conn.) Clock Company will erect a new five-story factory.

The Weatherly (Penn.) Foundry and Machine Company will erect a steel foundry.

The American Pulley Company, Philadelphia, Penn., will build a one-story factory.

The Ohio File Works, Niles, Ohio, will enlarge plant and install additional equipment.

Furst Bros. Company, Baltimore, Md., will build a $100,000 picture-frame factory.

The Bay State Brass Company, Haydenville, Mass., will make additions to plant.

The Susquehanna (Penn.) Metal Manufacturing Company will build a three-story addition.

The Babcock Electric Carriage Company, Buffalo, N. Y., will build an addition to plant.

The Ferro Machine and Foundry Company, Cleveland, Ohio, will erect a new machine shop.

The Ontario & Western Railroad Company is to build a new repair shop at Oswego, N. Y.

The Tuttle Hay Press Company, Kansas City, Mo., will erect new plant to replace present one.

A new roundhouse will be erected by the Reading Railway Company, at Pottstown, Penn.

The Chicago, Burlington & Quincy Railroad is preparing to build new roundhouse at Sterling, Ill.

The Perry-Fay Company, Elyria, Ohio, manufacturing screws, etc., is to double capacity of plant.

The plant of the Car Leather Company, Salem, Mass., was destroyed by fire. Loss, about $200,000.

The Pratt-Low Company, Santa Clara, Cal., will build an addition to cannery to be used for boxmaking.

The Bettendorf Axle Company, Davenport, Iowa, has let contract for the construction of its new foundry.

The Gordon (Neb.) Automatic Steel End Gate Company is to move to Ralston, where new plant will be erected.

The Gardner-Harvey Paper Company, Middletown, Ohio, recently organized, will erect plant at a cost of about $250,000.

The Elyria (Ohio) Iron and Steel Company is erecting an addition to finishing department which will double its capacity.

The Muncie (Ind.) Wheel and Jobbing Company will put up a new factory building for manufacturing automobile wheels.

An additional building will be erected at the plant of the Philadelphia Leather Works, at Bridesburg, to cost about $20,000.

The Kemp Machine and Foundry Company, Hattiesburg, Miss., will spend about $12,000 for additional machinery and stock.

The lumber plant of the Hayward Mill Company, Nacogdoches, Tex., was destroyed by fire, entailing a loss of over $100,000.

The West End Manufacturing Company, Tacoma, Wash., will erect a new and larger plant for manufacturing sash, doors, etc.

The Gilson Manufacturing Company, Port Washington, Wis., is planning to extend foundry and also to erect an additional testing room.

The Portland (Ore.) Railway, Light and Power Company is to erect a large central plant to take the place of the present three shops.

The United States Machine Company, of Detroit, Mich., building ice and cold-storage machinery, will move to Angola, Ind., where new plant will be erected.

The Carlyle Johnson Machine Company, Hartford, Conn., will remove to Manchester, Conn., where it will occupy the plant formerly operated by the Eastern Biscuit Company.

The Syracuse, Lake Shore & Northern R. R. Co., Syracuse, N. Y., is having plans made for a car house and machine and repair shop. William B. Rockwell is general manager.

The Illinois Traction Company, Champaign, Ill., is to erect a wood mill, brass foundry and other buildings at the shops in Dacatur. New woodworking machinery will be installed.

It is announced that a new boiler shop is to be built at the Brooks Locomotive Works, Dunkirk, N. Y., to cost about $300,000, and that $100,000 will be expended in enlarging and making other improvements at plant.

The Vulcan Iron Works, West Pittston, Penn., building mining and cement mill machinery, has just completed erection of new machine shop. The old machine shop is to be equipped for the manufacture of conveyers, elevators, hoisting cages, tanks, etc.

The Isthmian Canal Commission, Washington, D. C., will receive up to 10:30 a.m. April 26, proposals to furnish during the fiscal year ending June 30, 1910, the following: Hose, packing, rubber valves, gaskets, rubber belting, etc., as per Circular No. 501.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., April 19, for steel rails, frogs, angle bars, tie plates, track bolts and spikes, rivets, bolts, nuts, chain, iron and steel pipe, boiler tubing, steel, brass and copper tubing, babbitt metal, copper, bronze, brass, etc., as per Circular No. 499.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., April 21, for centrifugal pumps, steel and iron castings, steel forgings, tool steel, tubing, pipe and fittings, valves, bolts, rivets, screws, pulleys, grease cups, oilers, governors, jacks, drills, punches, saws, files, forges, grease, etc., as per Circular No. 500.

W. G. Brangham has resigned the superintendency of the American Sheet and Tin Plate plant at Chester, W. Va., in order to take charge of a new plant to be erected by an independent concern about to be organized. The Sinclair farm, near Holliday's Cove, Hancock county, W. Va., has been secured as site for the new plant.

The Pressed Radiator Company of America has been incorporated under the laws of Pennsylvania with $1,250,000 capital, absorbing the Pressed Radiator Company, a New Jersey corporation. The new company will enlarge plant for the manufacture of pressed radiators, and also engage in the manufacture of boilers and heating specialties. Works and principal offices are in Pittsburg.

The Elgin Tool Works, Elgin, Ill., will erect a new building to take care of its increased business. This building will be 48'x113', one and two stories, constructed of brick and concrete with a saw tooth roof. A 20 horsepower water wheel will be installed to furnish power, the cost of the plant approximating $10,000 and it will be ready for occupancy September 1. This company manufactures precision machinery, bench lathes and special tools.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: April 20—Hacksaw blades, crucibles, twist drills, files, saws (schedule 1115); bolts and nuts (schedule 1113). April 27—Rough brass valves (schedule 1133); hacksaw blades, emery cloth, twist drills, screws (schedule 1131); bolts and nuts (schedule 1133); air compressor (schedule 1124); engine lathe (schedule 1122); lathe, boring machine, drilling machine (schedule 1125); grinding machine, tool grinding machine (schedule 1123); plate bending rolls (schedule 1137); shaper (schedule 1122). May 11—Steam cocks (schedule 1136); steel, files, hand tools (schedule 1135).

New Incorporations

Parsons & Whittemore, Inc., New York, to manufacture paper, pulp, etc. Capital, $100,000. Incorporators, N. H. Parsons, H. Whittemore, R. Van Name.

Clark Machine and Foundry Company, Franklin, Mass., incorporated to manufacture machinery of all kinds. Capital, $60,000. L. P. Gifford, president.

Roundy Manufacturing Company, Boston, Mass., incorporated to manufacture and sell farm implements. Capital, $25,000. Incorporators, T. H. Keith, E. L. Roundy.

Chicago Steam Specialties Company, Chicago, Ill., has been incorporated to manufacture machinery. Capital, $100,000. Incorporators, E. P. Packard, A. Jackson, F. P. Leffingwell.

Chicago Automatic Selling Company, Chicago, Ill., incorporated to manufacture automatic vending machines. Capital, $200,000. Incorporators, C. R. Pope, G. H. Scott, C. P. Wurtz.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith, Columbia, Penn.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

We manufacture on royalty or buy outright patents on small tools. Box 104, AMER. MACH.

Wanted—Machinery to manufacture on contract. Hydrostatic Machinery Co., Rochester, N. Y.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Machines designed; automatic, special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Wanted—Punch press and jig work; good facilities for manufacturing of light articles. Models, dies, tools, etc., made. Joseph Pollak, 215 Sydney St., Dorchester-Boston.

Party wants to manufacture in Canada on royalty or commission basis, for Canadian trade, small tool or article which sells well in United States. Box 100, AMERICAN MACHINIST.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Wanted—To purchase a machine capable of flattening plates of perforated metal having plain margins, the buckles arising from the stretching of the center of sheets where perforated. Address "Metal," care Morse Agency, 19 West 34th Street, New York.

English engineer who is in New York to sell American patent (the English rights of which have been purchased by one of the largest firms in Great Britain) is desirous of introducing sound American inventions on his return to England. Advertiser is capable of placing and controlling anything from a cycle spanner to a locomotive, having good connections with all the best and largest firms in England. Apply "E. T.," care Messrs. Marwick, Mitchell & Co., 79 Wall Street, New York.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Good superintendency wanted by live producer. Now employed. Box 116, AMER. MACH.

Mechanical Draftsman—First-class man on both large and small machine designing; eight years' experience. Will go anywhere. Box 99, AMERICAN MACHINIST.

ILLINOIS

Adding machine expert, A-1 toolmaker and foreman desires change; age 30; present position, 5 years. Box 117, AMER. MACHINIST.

Young man having 10 years' experience designing machinery, would like position as demonstrator and salesman, at Seattle Exposition. A-1 references. "F. H.," 4233 Prairie Ave., Chicago.

Man with considerable experience as toolmaker and tool draftsman and at designing machine tools and special machinery for manufacturing purposes wants work in this line. Technical and reliable. Box 118, AMERICAN MACHINIST.

MASSACHUSETTS

Englishman, 26, married, alert and ambitious, seeks post as tool designer or assistant superintendent. Good mathematician and practical mechanic. Executive ability. Enterprising firm preferred. Box 103, AMER. MACH.

Wanted—Position as chief draftsman with small firm or assistant to chief with large firm, manufacturing medium weight machine tools or other machinery. Good designer with executive ability. Age 30. Box 86, AM. MA.

MICHIGAN

Situation Wanted—As superintendent or shop manager; 20 years' experience manufacturing small interchangeable parts. Thoroughly understand shop organization, cost systems, etc. Can produce the maximum at the minimum cost. Am an expert on all kinds of piece work. Am 38 years of age and married. At present employed, but desire to make a change; good reasons given. Can furnish best of references. Will go anywhere if salary is right. Box 48, AMERICAN MACHINIST.

NEW JERSEY

Draftsman and first-class all around mechanic, 28, with nine years' shop experience and four years as superintendent designer of special machinery, wishes position where he can make use of his practical knowledge. Box 113, AMERICAN MACHINIST.

NEW YORK

Mechanical engineer, college graduate, 10 years' experience in shop and office, desires position as manager or chief engineer of large plant involving complicated machinery or processes. Good executive. Address "Intricate," care of AMERICAN MACHINIST,

As superintendent, have wide experience with large concerns on fine interchangeable work; 22 years' experience; have ability, honesty and sobriety. Box 114, AMER. MACH.

Wanted—Position as foreman of milling machines, or would accept toolroom milling. Have had six years' experience and can give the best of references. Box 95, AMER. MACH.

Mechanical engineer, wide experience in building steam engines, explosion engines and compressor machinery, wishes position of chief engineer or general superintendent. Box 93, AMERICAN MACHINIST.

A competent man 35 years of age, with 15 years' experience in machinery and supply trade in New York, desires position with manufacturer or merchant as salesman or purchasing agent. Address "Vigilantia," Box 53, AM. MA.

OHIO

Engineer of established reputation, wide experience apprentice to works manager, intimate knowledge of best shop and machine tool practice on heavy work, gilt-edged record, is open for engagement as works manager with full responsibility and can deliver the goods. Box 865, AMERICAN MACHINIST.

PENNSYLVANIA

Toolmaker with broad training on all kinds of tools, long experience in sheet metal work; also experimental work, who could handle men to advantage, wishes position. Box 115, AMERICAN MACHINIST.

Advertiser, 33 years of age, an expert tool and die maker, who has spent over 12 years studying methods of production in almost every line of light interchangeable machine industry, desires to put his knowledge into practice and invites correspondence of firms having a vacancy for a first-class toolroom foreman, general foreman or superintendent. Anywhere in the U. S. A. Box 107, AMERICAN MACHINIST.

FOREIGN

Man, 42 years of age, with 15 years' experience as works manager, and 6 years' foreign sales manager, desires position as latter at London, with A-1 American engineering firm. Thoroughly familiar with English and Continental business; up-to-date hustler. Box A. 3, AMERICAN MACHINIST, 6 Bouverie Street, London, E. C., England.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Wanted—Mechanical draftsman for jig and fixture work. Box 77, AMERICAN MACHINIST.

Wanted—First-class toolmaker on jig and fixture work. No other need apply. Box 76, AMERICAN MACHINIST

INDIANA

Wanted—A-1 man for foreman drop forge department of 10 board and steam hammers. State experience, salary expected, reference. Address "Manufacturers," care AMER. MACH.

Wanted—Large automobile manufacturers want general foreman for machine shop employing 500 men. State experience, salary, reference, etc. Address "Automobile," care AMERICAN MACHINIST.

MARYLAND

Wanted—Several draftsmen who have had experience in designing automatic machines, at least one who is a thoroughly competent tool designer. Box 98, AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—Practical gear cutting expert on all classes of gear work. State age, experience and wages expected. Box 111, AM. MACH.

Wanted—An assistant to superintendent and general manager in a large gear jobbing shop. Must be experienced in mechanical work, technical and practical; also up-to-date on modern methods. State age, experience and salary expected. Box 112, AMER. MACH.

Wanted—A designing engineer familiar with modern high and medium speed steam engine practice; must be able to show a satisfactory experience and refer to a successful practice on not less than three years with a standard concern. A knowledge of economical manufacturing methods for quantity production desired. Box 102, AMERICAN MACHINIST.

Wanted—A general foreman familiar with modern practice in high and medium speed engine construction; must know how to get best efficiency from up-to-date tools and equipment. Only such applicants will be considered as can show an executive experience of not less than three years with an up-to-date manufacturing company. Familiarity with modern factory systems necessary. Box 101, AM. MACH.

MICHIGAN

Wanted—Machine-shop foreman with wide experience in modern shop practice to handle and direct 150 men. Plant located in Middle West — building heavy sawmill machinery. Man with technical education preferred. Box 40, AMERICAN MACHINIST.

Wanted—Foreman toolmaker who understands designing and making of drawing and stamping dies for medium size work. Tools for monitor and automatic screw machines. In applying give age, experience, references and salary wanted. Address P. O. Box 643, Detroit, Mich.

MISSOURI

Wanted—Strictly first-class men on Norton or Landis grinder; must be able to earn $25 or more per week on shaft work. Box 109, AMERICAN MACHINIST.

NEW JERSEY

Wanted—Hammersman: must be skilled on heavy forgings; steady work for a reliable and sober man. Address, stating experience and wages expected, "E. L. S.," AM. MACH.

In our rapidly growing business of the manufacture of a well known article, we always have openings for draftsmen and toolmakers on small tools, jigs, sub-press dies and special machinery. We invite applications from first-class men on this kind of work. Box 884, AMERICAN MACHINIST.

NEW YORK

Wanted—A first-class Jones & Lamson turret lathe operator. Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.

Wanted—Mechanical draftsman for detailing and tracing. Give experience and wages expected. Box 96, AMERICAN MACHINIST.

Wanted—Steel salesman. One able to demonstrate high speed tool steel and with shop experience. Apply with references and salary. Box 97, AMERICAN MACHINIST.

Wanted—Competent man with experience as speed boss and thoroughly familiar with premium system. Apply, stating age, experience, salary desired. Box 105, AMER. MACH.

Wanted—A thorough up-to-date man accustomed to tool stores departments and systems for plant of 1000 employees. Apply, stating age, education, salary expected. Box 106, AMERICAN MACHINIST.

Blacksmith wanted for machine blacksmithing, general tool dressing and tempering for large factory. Must have experience. Must be able to learn modern methods and to handle alloy steels. State fully age, education, experience, where worked, references, how soon could take position. Apply Adriance, Platt & Co., Poughkeepsie, N. Y.

PENNSYLVANIA

Wanted—First-class gas engine draftsman, one with steam engine and good shop experience preferred. Box 110, AMERICAN MACH.

Wanted—Man for office of contract machine shop. Must be able to make estimates and show profits. Box 108, AMERICAN MACHINIST.

RHODE ISLAND

Wanted—A first-class mechanical draftsman experienced on hoisting machinery. In reply state age, experience and salary expected. Box 78, AMERICAN MACHINIST.

For Sale

Valuable Canadian Patent—On labor-saving machine being rapidly introduced in the United States. Reynolds Machine Co., Moline, Ill.

Air Compressor—Ingersoll-Sargeant 10x10x10, class F, steam driven, 100 lbs. air pressure with 100 lbs. steam, 125 ft. capacity per minute at 150 r.p.m. First-class running condition (cost $800.00). Price $450.00 net. J. W. Paxson Co., Philadelphia, Pa.

For Sale—The American rights of an invention that is required in every workshop, railway and tramway system. Over 30 licenses granted to manufacturers in Great Britain. The English patent has been purchased by the well-known firm of Messrs. Vickers, Sons & Maxim, Ltd. For further particulars apply "E. T.," care Messrs. Marwick, Mitchell & Co., 79 Wall Street, New York.

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Record-breaking Engine Building

A 36x72-inch Heavy-duty Corliss Engine Was Completed in 30 Days from Receipt of Order by the Mesta Machine Company of Pittsburg

EDITORIAL CORRESPONDENCE

On February 24 last an order was placed with the Mesta Machine Company, of Pittsburg, Penn., for a 36x72-inch, heavy-duty, horizontal, left-hand, Corliss, straight-line-valve engine. Thirty days later, on March 26, the huge engine was completed—an achievement in rapid machine-building of which the constructors can well be proud. Referring to the accompanying halftone engravings, Fig. 1 shows this engine complete with the exception of the flywheel, which is dismantled.

The total weight of the completed engine is 400,000 pounds, of which one-half, or about 200,000 pounds, is in the heavy, 30-foot flywheel. Without an organization well trained to all the steps of heavy machinery building, the casting, machining and erecting of such an enormous weight of material would have been impossible in the brief space of four weeks and two days, or, say a calendar month.

The occasion of this rush was caused by the wrecking of the engine driving the 28-inch sheet mill of the Phillips Sheet and Tin Plate Company, of Clarksburg, W. Va. Delivery was asked for in eight weeks' time from the date of the order—this time was bettered some three weeks as the record shows. In order to give a better idea of the magnitude of the feat, we will consider the molding, casting and machining of the larger pieces in detail.

The Bedplate

No suitable bedplate pattern was available. Thus it was necessary to make a new one entire—this for a casting that weighed 105,000 pounds. The time for making the pattern ready to mold was 70 hours; the completed pattern was delivered to the foundry on February 27. Molding was finished and the casting was poured on March 8; four days later, on March 12, it was stripped, pulled from the sand, cleaned, and delivered to the machine shop on March 15, 19 days after receipt of order. The machine shop finished its share of the work on this piece in six days, sending the finished bed to the erecting floor on March 21, or 25 days from the date of starting.

Figs. 2 and 3 show this bedplate in the process of machining. In Fig. 2 the Newton boring machine is drilling the holes for attaching the cylinder. In Fig. 3 a Morton draw-cut shaper can be seen machining the main bearing. In passing, it is interesting to note a section of a 600-ton steel mixer in the foreground of Fig. 2, and a rolling-mill bedplate at the right in Fig. 3. Also in Fig. 3, at the extreme farther corner of the shop, and somewhat indistinct, is the finished cylinder as it awaited erection.

The Flywheel

The most difficult part to produce in the allotted time was the flywheel. It is a 30-foot 10-segment wheel, with an 18-inch face and a 29-inch bore; total weight, 100 tons.

A pattern was available, but, of course, to get the 10 segments, it had to be molded 10 times. Two flasks were used and the 10th segment was delivered to the machine shop on March 7, eleven days after commencing the job. The planing time for each segment was eight hours, or 80 hours for the lot. All of this work was done on one machine. One day was required to assemble the wheel on the floor preparatory to drilling and reaming for the taper hub bolts. In Fig. 4 the wheel is shown thus assembled. Two portable radial drills are in use on the drilling and reaming operations; 170 hours were required. The necessary taper bolts were ten 24x3 ½-inch and twenty 29x3½-inch, indicating the

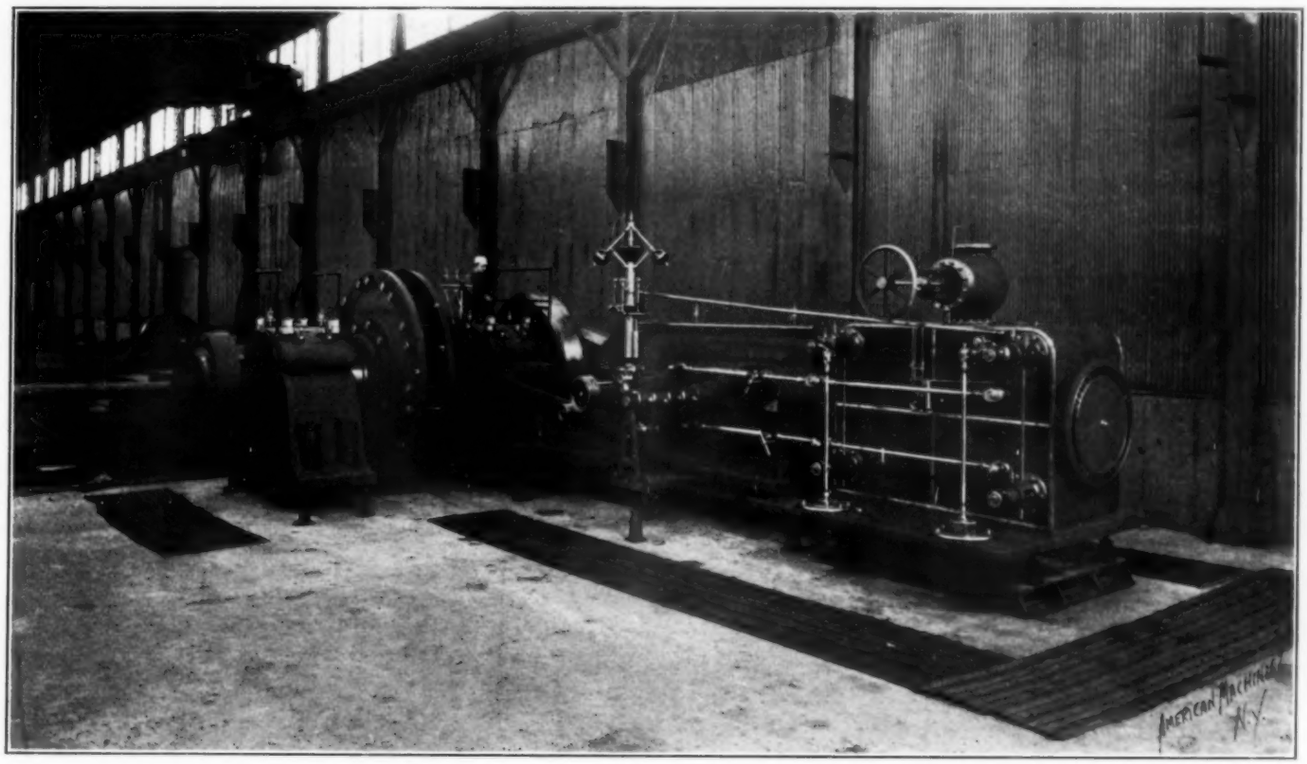


FIG. 1. A 36X72-INCH CORLISS ENGINE BUILT COMPLETE IN 30 DAYS

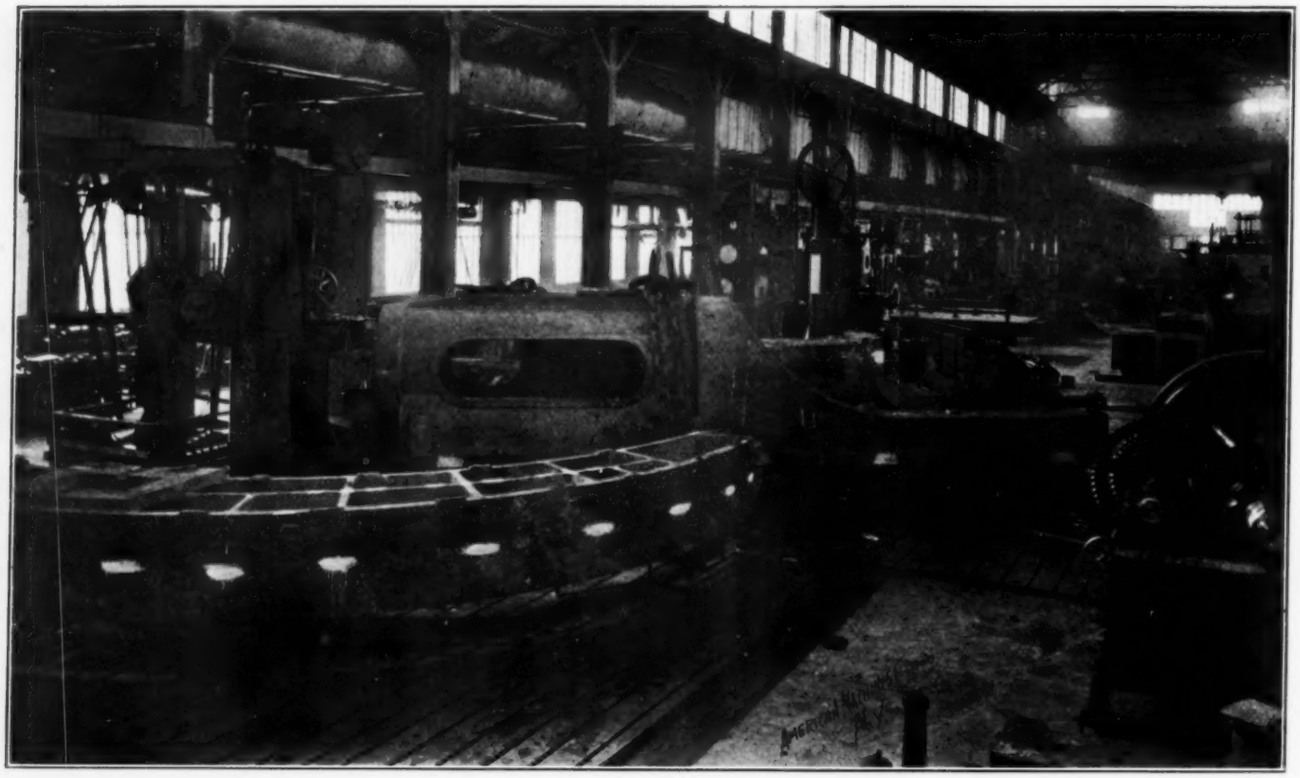


FIG. 2. MACHINING THE ENGINE BED-PLATE—DRILLING THE CYLINDER HOLES

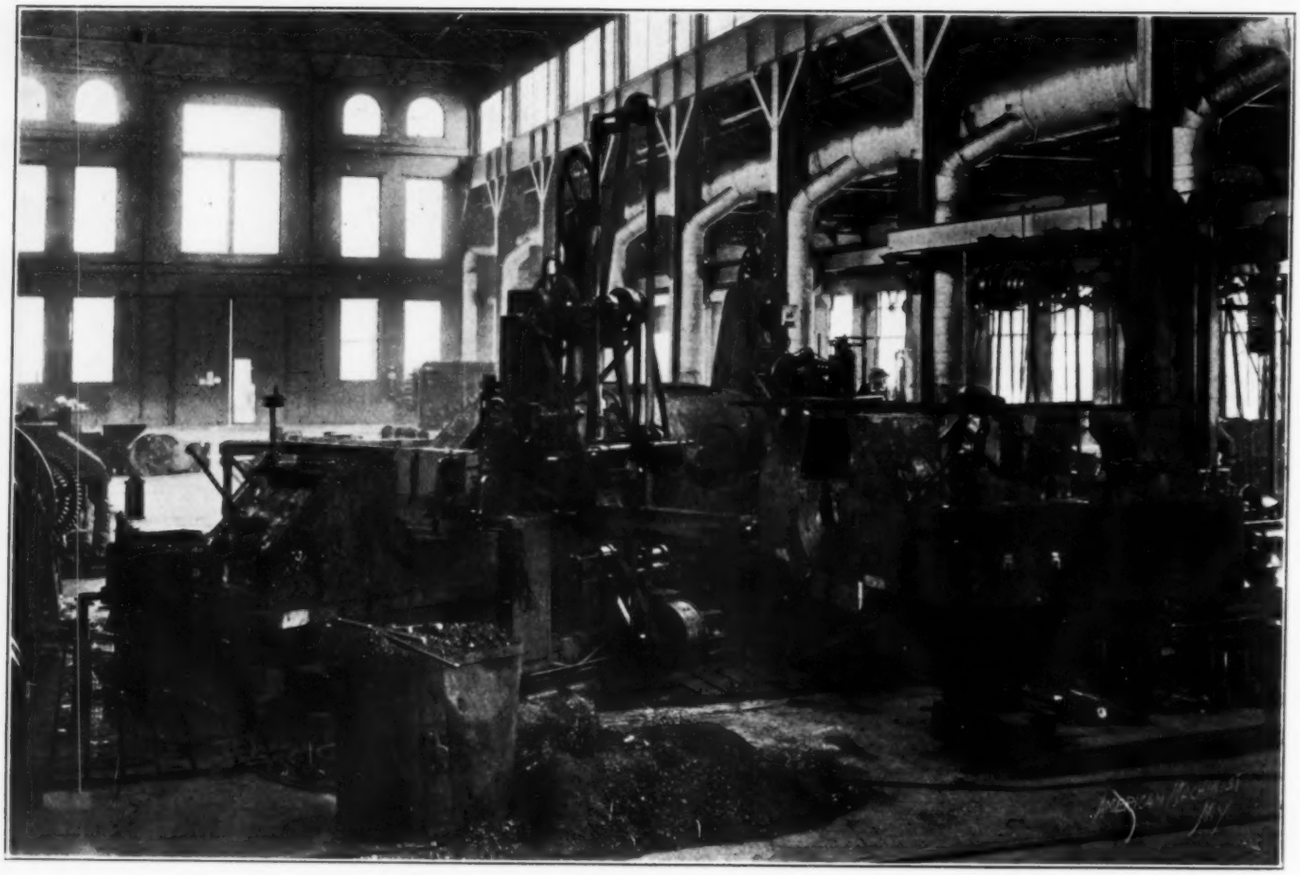


FIG. 3. ANOTHER VIEW OF THE MACHINING OF THE BED PLATE—PLANING THE MAIN BEARING

size and length of the holes that were machined.

Then followed the dismantling of the wheel, assembling of the hub, the boring of the hub, assembling of the entire wheel in the pit lathe and turning. Three days were spent in turning; the wheel was completed on March 21, 25 days after receipt of the order.

As an incidental item the prisoners for the wheel—30 in number—are of a 5x6-inch section and 36 inches long. Fig. 5 shows the assembled wheel in the pit lathe during the operation of turning.

Cylinder and Shaft

A cylinder pattern was remodeled to use for the cylinder casting of this engine. This remodeling consisted in lengthening a 36x48-inch pattern to the 36x72-inch required. The casting from this remodeled pattern reached the machine shop on March 6, or after an elapsed period of 10 days, and it was entirely completed, including the lagging, on the 13th, or more than a week before erecting commenced. The main shaft proved to be an element of delay. The steel firm from which the shaft forging was ordered did not make delivery until three days after the date of their promise, or on March 17. Six days later, on March 23, the finished shaft weighing 24,600 pounds was delivered to the erecting floor, thus as it turned out, the shaft delayed the work of erecting for three days; otherwise, the enviable record of 30 days from order to completion of this large engine might have been reduced to 27, or by 10 per cent.

A few of the dimensions of this shaft are: Center to center of main bearings, 10 feet; main bearing, 23x42 inches; other bearing, 22x40 inches; diameter of wheel seat, 29 inches. On the shaft are shrunk the cast-steel crank disk, the wheel hub and the cast-steel coupling. These three parts show in Fig. 1.

The other parts caused no especial worry or consideration in the making; the valves, valve gear and governor were all finished in ample time.

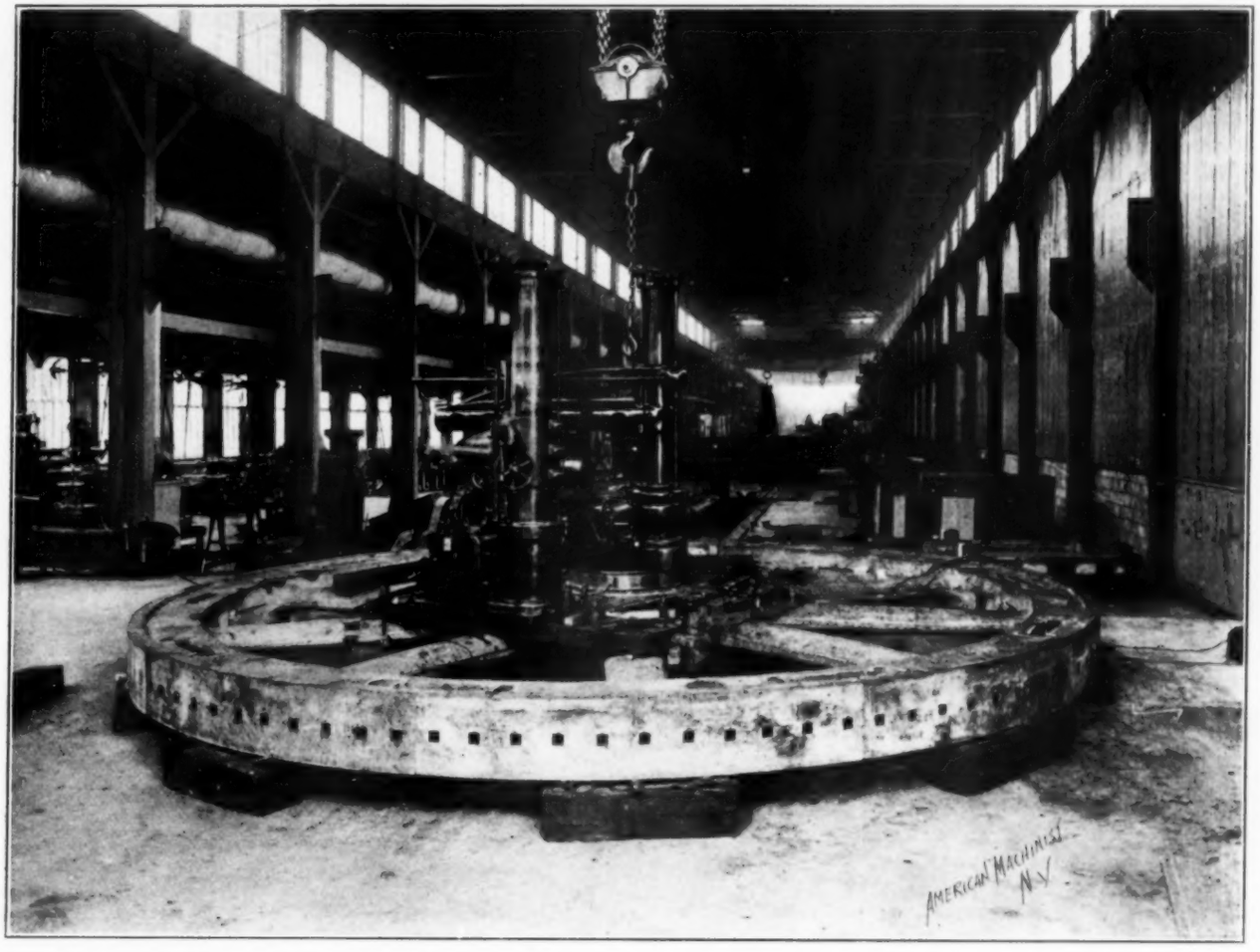


FIG. 4. MACHINING THE ENGINE FLYWHEEL—DRILLING AND REAMING

Assembling, Disassembling and Shipping

All of the parts were ready to assemble on March 23; the delinquent was the main shaft, as we have mentioned.

On the following Friday, March 26, the engine was completely assembled, as shown in Fig. 1. It was then held for one day—to be viewed by invited members of the Engineers' Society of Western Pennsylvania and other guests during Saturday afternoon, March 27. Disassembling then took place, and on Monday, March 29, loaded on five freight cars, it left the Mesta yard. On April 1 it was delivered at its destination, Clarksburg, W. Va., and erecting in place began on the following day. This should take about eight days, or, say a total of 45 days from the date of the order until ready for steam.

Horsepower Ratings

The horsepower ratings of this engine may be of interest. These can only be given for assumed conditions, for the engine will be used under the severe, fluctuating requirements of rolling-mill work. Its normal speed is to be 30 revolutions per minute with a steam pressure of 150 pounds gage.

Under assumed conditions of 70 revolutions per minute an average speed for engines of this type when used for ordinary power purposes, with 150 pounds gage pressure of steam and one-quarter cut-off, the indicated horse-power would be about 2000. Under the above assumed conditions, but with three-quarters cut-off, the indicated horsepower would be about 3500.

Horsepower of Group Driven Machine Tools

By Geo. H. Schaeffer

The following is a description of a test made some time ago on a group of new machine tools, belted to new shafting and driven by a new motor. In fact the conditions were ideal and the test was made under actual running conditions:

Arrangement of the Machines

The machines are arranged in a line and belted to shafting. The shafting is 3 inches in diameter, 180 feet in length and supported by 19 hangers. The motor is belted onto the shafting for flexibility. The motor is at one end of the shafting. The rating of motor is 30 horsepower, making 600 revolutions per minute at 220 volts taking 112 amperes direct current. The group of machines consisted of: 3 slotters, 6-inch made by Bement-Miles; 2 millers, 4B made by Becker-Brainard; 2 millers, 5B made by Becker-Brainard; 10 millers, 3 made by Shipley; 2 millers, 4 made by Shipley; 2 shapers, 16-inch, made by Bement-Miles; 2 shapers, 16-inch, made by Shipley; 1 grindstone 3 feet diameter, 4 inches thick.

Electric meters were connected so that the power taken at any moment could be read. The object of the test was to get the total power consumption for all conditions of running.

Power Required to Start the Shafting

In this test all of the machines were on the off position and the motor and shafting were started from rest and brought gradually up to full speed. The maximum power consumed was at the point of starting and reduced gradually as the motor came up to speed.

Maximum power consumed,	Per cent. of full load of motor,
31,350 watts.	125.

After bringing the shafting up to speed, all the machines being on the off position, the power consumed by motor and shafting running light was 7700 watts; per cent of full load of motor 31.3.

All the machines were next turned on and run at full speed. All the machines were running light, however, no actual work being done. The total power to run shafting and all the machines light was: 10,800 watts; per cent. of full load, 43.

The next step was to get the total power consumption for the group when all machines were running and actually cutting. Each machine was put into service and total power was 11,850 watts; per cent. of full load, 48.

The next step was to get the power consumption under normal running conditions. Ordinarily about half the machines are cutting or doing work at any one time. This is on account of the character of the work, it being necessary to take many small cuts and to reset the work, each cut and each resetting of the work causing a shutdown to that particular machine. Instantaneous readings were taken every few seconds for an hour and the average consumption was 9650 Watts; per cent. of full load, 40.7.

Next the efficiency of the motor was considered. The friction, windage and stray power was 975 Watts. To this was added the copper loss in the armature and fields. The minimum efficiency occurred at the lightest load, and that is when only shafting runs light. This efficiency is 80 per cent. Maximum efficiency is at maximum load or when motor and shafting are brought up to speed from rest. This efficiency is 91 per cent. The efficiency under normal running conditions is 83.5 per cent.

It was then thought interesting to calculate the exact amount of power used to shear off the metal. This was worked out theoretically and results are useful for comparative results only. The feed, depth of cut and grade of material and rate of cutting were ascertained for each machine running at the time of the test. With this data and the shearing stress for the different materials we calculated energy usefully expended at the tool. Under ordinary running conditions, with half the machines

TABULATED RESULTS OF TEST.

	Watts.
Power required to start machines from rest	31,350
Power required to run shafting light	7,700
Power required to run all machines without cutting	10,800
Power required to run all machines with cut	11,850
Power required to run machines under normal working conditions	9,650
Power lost in motor under normal working conditions	1,590
Power actually used to remove metal under normal running conditions	425

FIG. 5. MACHINING THE ENGINE FLYWHEEL—TURNING

cutting this amounts to 420 watts. The total power consumption under these conditions is 9650 watts, so that the amount of energy actually used at the tool point is a very small percentage of the total output,

$$\frac{420}{9650} \times 100 = 4.35$$

per cent., actually.

The tabulation shows the comparative results and the distribution of the power in watts in the different operations. This shows the power used to start the shafting from rest, to run the shafting light, to run the shafting and machines without cutting, to run all machines cutting, also the power required to run machines under normal working conditions.

The Landgraf-Turner Alternating Impact Machine

In a paper recently read by Prof. J. O. Arnold, of Sheffield, England, a method of performing fatigue or "dynamic" tests on metals was described, in which tests two important factors were introduced, namely, stressing the steel beyond the limit of elasticity and subjecting it to a decided shock or impact at each alternation of stress. The introduction of an impact is of great importance as many metals which may endure for a long time under heavy load will break instantly under the influence of sudden shock. The impact test is of especial importance in the determination of the relative qualities of such high-grade materials as the alloy steels now put to such exacting service in modern engineering practice. In comparing his tests with the usual Wohler test, Professor Arnold's method may be stated as being equivalent in effect to firmly gripping one end of a bar in a vise and rapidly knocking the other backward and forward with a hammer. These blows require to be repeated at a rate which it would be impossible to maintain without the aid of a machine. The rate has not only to be kept constant but the degree of deflection imparted to the bar must be the same at every blow. A deflection must be chosen such that the material regardless of its strength and stiffness will be given a permanent set at every impact applied. Professor Arnold and other investigators using this principle have improvised shaping or slotting machines to perform the tests, using a tool-steel head in which is cut a slot of length according to the deflection desired, for the purpose of imparting the impacts. With a view to providing means whereby these tests may be performed under uniform conditions and so render possible accurate comparison of results obtained by individual investigators, the machine shown in the accompanying engravings has been designed by F. K. Landgraf and W. L. Turner, the builders of the machine being Queen & Co., Incorporated, Philadelphia, Penn.

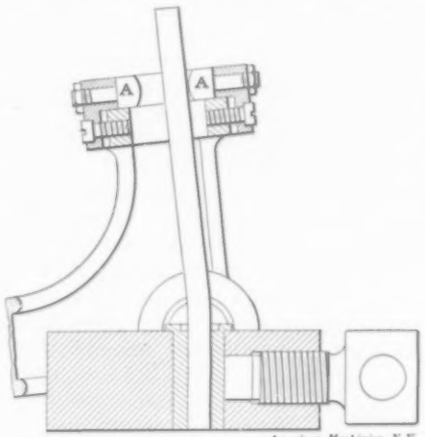


FIG. 3. HOW THE TEST PIECE IS OPERATED UPON

Features of Construction

Figs. 1 and 2 are general views of the machine showing the principal features of construction. It will be noticed that the mechanism is very compact; in fact it weighs in all about 90 pounds and its hight from base to top of flywheel is but 13½ inches. In place of the straight-line movement of the shaping machine, a rocker arm is here substituted for the double purpose of economizing in space and, by reason of its radius being equal to the free length of the test piece, maintaining a constant leverage during the whole stroke.

The two halftones show side and front views of the machine with the test piece deflected to the full extent. The top end of the specimen will be seen to be gripped in a clamp which is connected to a lever

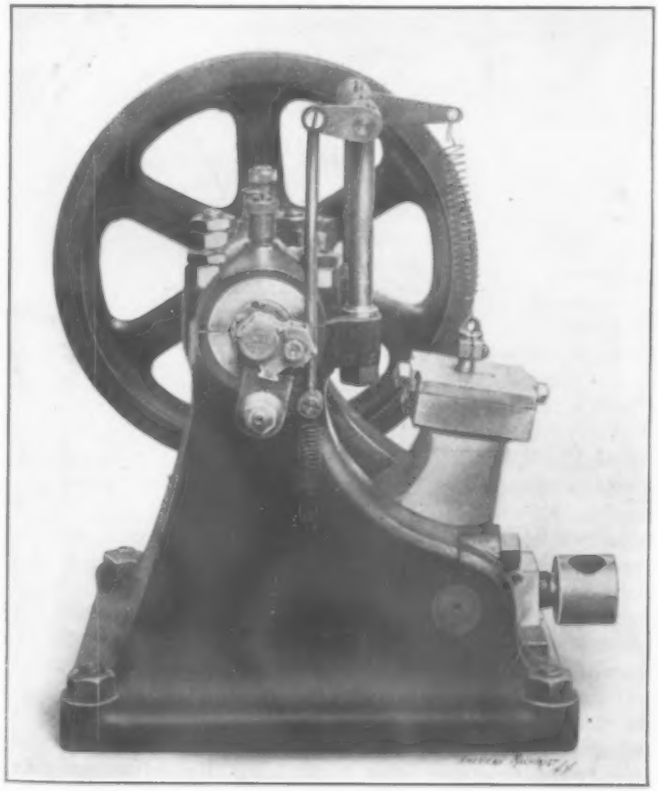


FIG. 1

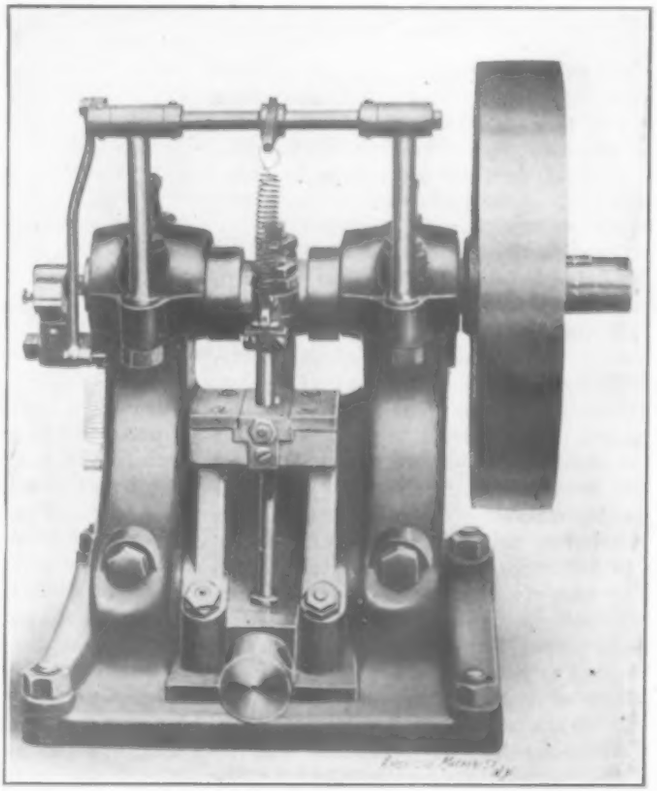


FIG. 2

LANDGRAF-TURNER ALTERNATING IMPACT MACHINE

by a spring. This attachment is part of the counting mechanism, performing two distinct operations, (1) it brings the Veeder counter into gear with the crank shaft when the clamp is fastened to the end of the test piece, and (2) when the test piece breaks, the tension in the spring is relaxed, allowing the counter to resume its original position and stop registering. The test piece is also pulled from out of the slot. After starting the machine it may be left to itself without any attention whatsoever. A double counter is provided, one dial of which acts as a totalizer while the other can be set back to zero at will. Since there are two alternations of stress to every revolution of the crankshaft it is necessary to multiply the figure on the counter by two.

Fig. 3 is a sectional drawing showing the test bar firmly clamped in the vise and deflected to one side by the action of the rocker arm. This vise is seen in the half-tone Fig. 1. It consists of two steel die blocks which, by inserting a steel bar in the head of the screw and tightening it up, are made to firmly grip the test bar (which is 8 inches long) for a length of an inch and a half. After fracture has taken place the screw is loosened and the end is made to fall through the base of the machine, being caught in a box for the purpose.

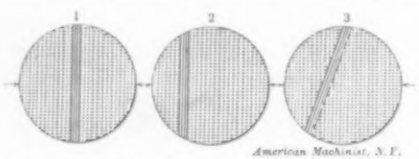


FIG. 4. FINAL LINE OF FRACTURE IN TEST PIECES.

The vise jaws furnished with the machine are for gripping three-eighths specimens, but if it is desired they may be applied for rectangular sections to suit the requirements of sheet and plate manufacturers. The top of the rocker arm is fitted with two tool-steel hammer dies *A A*, Fig. 3. Their function is, of course, to deflect the bar after impact. It will be seen that there is a space or slot between them which, by allowing the specimen to be free from the rocker arm at some part of the stroke, introduces the impact or shock at each alternation of stress. The larger this slot is made, the smaller will be the deflection. It is customary to test with a width of slot of three-quarters of an inch. The stroke of the machine is one inch and an eighth, so that the top of the test piece is deflected to a distance of three-eighths of an inch on each side of its mean or neutral position, or a total range of three-quarters of an inch. Sometimes, however, it is required to give the metal (especially in the case of steel castings and brittle materials), a less drastic test than this. The instrument is, therefore, provided with two extra sets of hammer dies which may be easily inserted or removed. One set gives a width of slot of one inch and the other brings it up to an inch and an eighth. Another feature is that this slot may be moved in one direction or the other so that should the test piece be not quite at the center of the slot at mid-stroke the error may be compensated for. It might also possibly be desired to experiment upon the effect of deflecting to a larger extent in one direction than in the other. The distance from the top of the vise to the striking point of the hammers, or in other words, the free length of the specimen, is four inches. This combination of free length and deflection is sufficient to give a permanent set to all materials; such might not be the case, however, when the one-inch or larger slot is used.

The test piece is a very simple member to prepare, consisting of a straight, cylindrical rod three-eighths of an inch in diameter by eight inches long, and the complete test can be made in a minute or two and without attention upon the part of the operator after the machine is started.

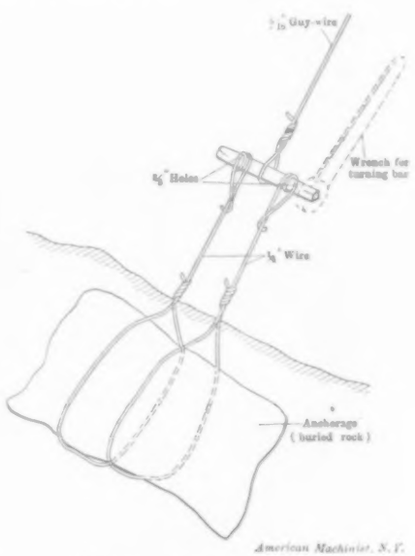
Results of Tests

A desirable feature of this machine is that it is possible to make two tests on each piece and thus secure an indication of the regularity of the material. As a general rule two test pieces should be made for a given experiment, an average being taken of the four tests resulting therefrom. The fractures given on these tests are highly interesting, not only by reason of the diversity of the types but also because they detect, by the final line of fracture, any gross unhomogeneity in the metal. Thus Professor Arnold in his paper stated in regard to the appearance of the fracture under his method of testing: "The author's tests were frequently found to give unexpected information of considerable value in determining, not to say the homogeneity, which in such connection is an absurd term, but the evenness of a fracture of a steel as regards the crystallization of its ferrite and the distribution of its pearlite and sulphide of manganese. It should, however, be remembered that a steel with unsatisfactory properties— in other words a steel of bad quality—may nevertheless be even in texture, while conversely a steel of uneven texture may, as a mass, be of good quality. The circles forming the diagrams of Fig. 4 indicate three types of texture to be observed in mild steels. The direction of the tension stresses and the original points of maximum stress are indicated by the arrow heads. Circle No. 1 represents a fracture of a steel of very even texture, in which fracture has commenced almost simultaneously at exactly opposite points on the skin of the test piece, and proceeded at identical rate inwards, meeting on a line indicating the theoretical zero of stress. The area of metal last to fracture is a strip which breaks in tension under the last strokes of the plunger, leaving a gray line distinct in appearance from the two half circles constituting the main fracture; thus, as in circle one, this line is registered in the middle of the bar and at right angles to the direction of stress. In circle 2 is represented the fracture of a bar of very uneven texture, in which rupture had commenced on the right-hand skin considerably before the metal began to break on the left-hand skin, so that the gray line, showing a final tensional fracture, bisects the left-hand semi-circle of the bar, but, as in case 1, is still at right angles to the direction of stress. Circle 3 shows a case in which fracture begins at the right-hand skin before the higher quality of the steel on the left-hand skin began to rupture, but the fracture had proceeded in a direction not at right angles to the line of stress but at the angle indicated by the line of final fracture in circle 3. It may be remarked that evenness or unevenness in texture as indicated by the position and angle of the final line of fracture has been found to be persistent along a test bar for several inches."

A Take Up for Guy Wires

By Arthur Lowry

A cheap and very effective means of taking up slack in guy-wires is used in hop-growing parts of Bohemia.



A TAKE UP FOR GUY WIRES

The hop vines are hung on a wire skeleton about 40 feet above the ground, this in turn being supported by 8-inch pine poles. The take-up for the guy-wires which steady the poles is shown in the line cut. This arrangement is cheaper, and for unskilled labor simpler, than turnbuckles. Since there is hardly anybody around the hop gardens for the greater part of the year, this method has the advantage that it can't be easily tampered with, as is the case with turnbuckles.

Newark, N. J. A. L.

The Automatic Telephone Central

A New Step in the Conquest of the World by Automatic Mechanical Devices Which Show an Almost Human Degree of Intelligence

BY SNOWDEN B. REDFIELD

It is a matter of but a few years when a person desiring to call another on the telephone will not only make all his own electric connections for talking, but will deposit his money in an automatic meter, talk as long as he likes and then have his change automatically handed back to him.

All those who have occasion to use the telephone, and this classification takes in practically every inhabitant of every civilized country in the world, have often had occasion to wish that the personality of the telephone central could be eliminated. It is said that from this very wish the idea of the autómatic telephone central had its origin, for one of the early inventors along these lines, Almon B. Strowger, was spurred on in the field of automatic telephony very largely by his exasperation over the annoying performances of the "hello girls" in his own town.

There have been rumors of automatic telephone centrals for several years, but the idea in the mind of the general public is that these automatic machines are applicable only to very limited service, and that it would be an impossibility to extend them for use in a city. This idea, however, is entirely erroneous, for the day is doubtless approaching when all telephone-central work will be done by automatic devices. As these machines are now being put out by their manufacturers, there is no reason why there should be any limitation at all to the extent of the service.

One of the companies which is turning out automatic telephone centrals is the American Automatic Telephone Company, of Urbana, Ohio. The telephone system which it is manufacturing and installing has the characteristic of being a two-wire system as opposed to the old three-wire system, used for both manual and automatic operation. The system also uses central energy; that is, the electric current for talking and for ringing and for the operation of the automatic central devices is furnished from the central office itself. The whole operation of switching, to connect any one subscriber to any other subscriber is entirely automatic without any manual intervention in the central office. In this way a subscriber puts in his own calls, and his getting of the right number depends only upon himself. When his number has once been obtained there is no possibility of interruption from the outside, and also there is no possibility of his conversation being overheard.

The Automatic Switches

The telephone itself, as is well known, is about the most complicated device at present in use, and when the central office is made automatic an explanation of its operation to be at all understandable to those not directly educated in telephone work, must necessarily deal only with the general principles. The transmitting and receiving devices are of the same general design as those used on the ordinary manually operated telephones. The only difference in appearance is in the calling device, which, as seen in Fig. 1, is very inconspicuous and does not in any way detract from the simple appearance of the telephone itself.

Fig. 2 illustrates one of the central-office switches, known as the "connector." In

FIG. 1. DESK FORM, WITH CALLING DEVICE

this figure E will be seen to represent a bank of 50 groups of contacts over which the arms F are made to travel by means of the motor magnet $M\,M$ so as to connect to the proper telephone lines. The motor magnet operates upon the ratchet wheel to push the arms F around one step for each vibration of the armature of $M\,M$. Ten vibrations would move the arms F 10 steps, 15 vibrations would move the arms 15 steps. R is the release magnet which, when the receiver is finally hung up after the conversation is finished, allows the arms F to swing back to the extreme left-hand or disconnected position. G is a relay which furnishes current to operate the motor magnet $M\,M$. The relay G takes only the small current flowing in the telephone line itself, when the receiver is removed, but by its operation a current heavy enough to positively operate the motor magnet is passed through the coils of the latter.

In all of these automatic switches there is used what is termed a "slow magnet," at various steps in the operation. These slow magnets resemble an ordinary electromagnet composed of a soft-iron core covered with a coil of insulated wire, but in addition there is a copper sleeve placed over the soft-iron core and under the wire winding. The effect of this copper sleeve is to prevent the magnetism in the soft-iron core from being lost immediately after the current is cut off from the coil. In this way if the slow magnet is energized by a current and rapid breaks and makes are produced in this current, the magnetism does not have time enough to become inactive during the interval that the current is broken. The effect of this is to keep the magnet practically constantly magnetized, holding its armature in place during the time that a more or less rapidly interrupted current is being passed through its coils. The use of this device will be seen in the later explanation.

Sending in the Call

In order to connect any one subscriber to any other, the subscribers are divided into groups of 500. These groups of 500 are brought down to groups of 50, and finally down to the single subscriber. The various groups and individuals are reached by a succession of switches, which are thrown one after the other by impulses which are sent over the telephone line by means of the calling device shown in Fig. 1. Fig. 3 is a closer view of the calling device, which the manufacturers term their "sub-station selector." This device is nothing more nor less than a clock-work mechanism, designed to operate an electric commutator, which is shown in the right-hand view, Fig. 3. One revolution of the commutator sends one current impulse over the line; two rotations send two impulses, and so on. By rotating the mechanism any given distance, a predetermined number of impulses can be sent over the line in succession.

The call numbers are made up of letters and numbers. For instance, let a subscriber's number be D C 12, the handle on the front of the calling device is turned so that the pointer comes opposite

the letter *D*. The handle is pressed down, which inserts a pin in one of the holes around the circumference of the calling device. The lever is then moved around to the right until it strikes against the stop at the bottom. It is then released and allowed to turn back again by its own spring mechanism. Next, the pointer is brought opposite the letter *C* the lever is again pressed down, inserting the pin and the device rotated and allowed again to spring back to its normal position. After this the pointer is placed opposite the numeral 12, and the device again allowed to spring back. Each one of these processes of springing back has sent over the line by means of the commutator, a number of impulses corresponding exactly to the letter and the number; the letter *D* corresponding to 15 impulses, the letter *C* corresponding to 10 impulses, and the numeral 12 corresponding to 12 more impulses. The first set of impulses moves one switch, the next set moves a succeeding switch, and a final set of impulses moves the final switch. After this the calling device is again rotated for a short distance, which causes a ringing relay (*K*, Fig. 2) to be thrown into operation, thus ringing the bell on the telephone of the subscriber being called.

By these successive sets of impulses any number may be called, as it is not at all necessary to make the number of holes, or revolutions of the commutator, more than a mere fraction of the number of the subscriber. As a matter of fact, the first set of impulses connects with a group of 500 subscribers, the second set limits this to 50, and the third set of impulses finally locates the individual. In this way it is seen that so far as the matter of calling is concerned, there is absolutely no limit to the size of the calling number, nor the number of subscribers on the line that may be called with an automatic device such as this.

In order to explain the system it will be best to remove as much as possible all elements of complication by limiting ourselves to the case of one of 50 subscribers talking to any one of 5000 subscribers. By limiting it to but one person talking at a time, the matter is made much clearer and the elements of multiplication are entirely removed, while a reasonably clear idea of its general operation will be obtained.

Getting the Connection

Fig. 4 is a diagram of an automatic system which will allow any one of 50 subscribers to talk to any one of 5000 on the system. In this figure, *A* is termed the "finder switch," *B* is termed the "first selector," *C* the "second selector," and *D* groups of 10 "connector switches." All of these switches are very much alike; in fact, the parts are nearly all duplicates, although differently arranged and differently connected in the various switches, and they all bear the general appearance of Fig. 2. The finder may be described as a selector or connector, operated in the opposite direction.

In Fig. 4 let it be assumed that the subscriber on line *Y* wishes to talk to the subscriber on the line *X* in the second group *D'* at the top of the figure. There are 50 separate telephone lines coming into finder *A*, and when the subscriber on line *Y* removes his receiver, the connections to the central office and the finder *A* are such that what is known as a "vibrating relay" which operates somewhat on the principle of an electric bell, and which is part of the finder itself, furnishes an intermittent current to its motor magnet *M M*, as shown in Fig. 2, causing the arms *F* to rotate, passing over the contacts in the bank *E* until a point is found where no ground connection is established. This will be the line *Y*, from which the receiver has been removed. The effect of this new connection then throws a relay, stopping the motor magnet *M M* and the arms *F*, in finder *A*, come to rest upon the contact corresponding to the line *Y* in Fig. 4.

The next step is for the subscriber to rotate the calling device, as already described, giving the correct number of impulses to operate the motor magnet on the first selector *B* in Fig. 4, sufficiently far to meet the contact in *B*, leading to one of 10 second selectors, *C'* in Fig. 4. The succeeding set of impulses sent in by the subscriber will operate the motor magnet in *C'* a number of steps corresponding to the number of impulses in this set, turning the switch in *C'* up to the next desired contact. When this second set of impulses is being sent over the line the first selector switch *B* has no tendency to rotate farther, because when it came to rest a slow relay in first selector *B* was allowed to operate and throw what is called the auxiliary or "side switch," in *B* (shown at *X*, Fig. 2), which cuts out the motor mechanism in first selector *B*, thus giving it no tendency to rotate farther for succeeding sets of impulses.

After the second set of impulses has been sent over the line the auxiliary switch on second selector *C'* does the same thing for this switch, and when the calling subscriber sends out the third set of impulses these are passed on to the one of 10 connector switches in the group *D'* which is connected to the contact upon which the switch in second selector *C'* came to rest. In the diagram this is shown to be the second upper connector switch in the group *D'*, and this last set of impulses moves the switch in this connector around to the contact corresponding to the number of impulses in the last series sent out by the calling subscriber. This contact would correspond to the line *X* on this connector switch, which leads to the subscriber that it is desired to call.

This, then, makes the connection complete through from one 'phone to the other, and the last operation is the fourth turning of the calling device which operates the ringing relay (*K*, Fig. 2) in the last connector switch, which throws current through the line *X* to ring the bell on that particular telephone. As soon as this subscriber answers, the conversation may be continued as long as desired, and when completed the receivers are hung

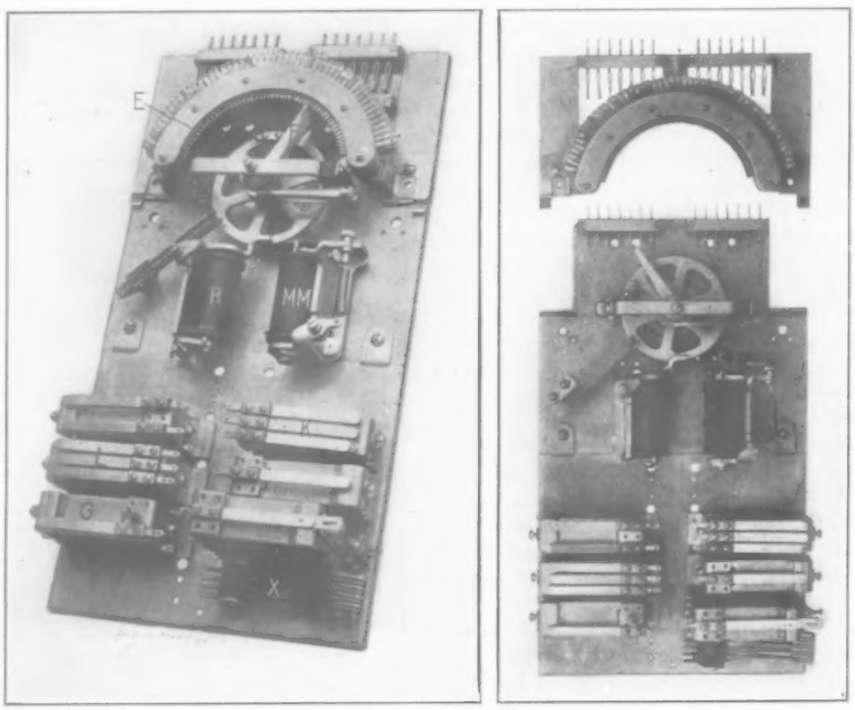


FIG. 2. CONNECTOR, OR FINAL CENTRAL OFFICE SWITCH

up in the usual manner. The hanging up of the receiver causes the operation of the release magnet in each switch, which has already been spoken of, and this allows the switch arms on all the various switches to swing back to the left-hand or off position, thus breaking the connections. In this way it is seen that any one subscriber connected to finder *A* can first make connections to the first selector, which in turn will connect him to any one of 10 second selectors. This second selector will connect him to any connector in any one of the 10 groups of 10 connectors each, and as each connector leads directly to 50 subscribers, the 10 groups of 10 connectors each make up the total number of 5000 subscribers illustrated by the diagram. This principle may be extended as far as desired for any one central station, and by means of trunk lines from one central to another, just as with the manual system, these various centrals may be connected together and a telephone system of practically unlimited size may be thus made entirely automatic in every way.

Several Talking at Once

By putting in 100 finders instead of one, all properly connected to corresponding first selector switches, and correctly multipled together, it will be understood that any one of 5000 subscribers can talk to any other one of the same 5000; that is, only one person talking at a time. As it is, of course, necessary that more than one person in 5000 should talk at once in such a telephone system, it is necessary to make provision for this.

As a matter of fact, instead of there being one finder to every 50 calling subscribers there are six finders for every 50 subscribers, and there are six first selectors corresponding to each six finders; that is, one first selector for each finder. Instead of there being only 10 contacts on the first selectors and the second selectors there are 10 groups of five contacts; that is, 50 contacts in all. These contacts are so multipled together that in case the turning of the switch, say on the first selector, should bring it to a line leading to a busy second selector, its coming to rest for an instant allows one of the little slow magnets to operate, throwing in a vibrating relay on the first selector which sends a further set of impulses into the motor magnet in this same first selector, causing it to rotate until it reaches one of the multiple non-busy lines leading into the same group of second selectors desired.

Instead of there being but 10 second selectors for each first selector, there are 40 second selectors for each first one, these being in groups and multipled together on the groups of contacts in the bank of 50 contacts on each first selector switch. Thus, in case a subscriber tries to call in on a busy selector switch on the way to the final connector switch, which he desires to reach, which latter we will assume, is not busy, the machine itself automatically hunts out a contact in the selector which is not busy and passes on the call to the next switch which is also not busy, and provided the final subscriber desired is not using his 'phone at that time, the ultimate connection is attained.

This automatic hunting out of non-busy wires is one of the most interesting and essential features of an automatic calling system. It necessarily introduces considerable complication into the system, but the principles upon which it operates are beautifully simple when carefully studied, although the connections made are indeed exceedingly complicated. If the individual 'phone called should happen to be busy, a relay (*L*, Fig. 2) in its connector will automatically give the "busy tone" to the calling subscriber, and furthermore, it is impossible for any new connection to be made to a busy 'phone, thus removing this common source of annoyance in manual telephone service.

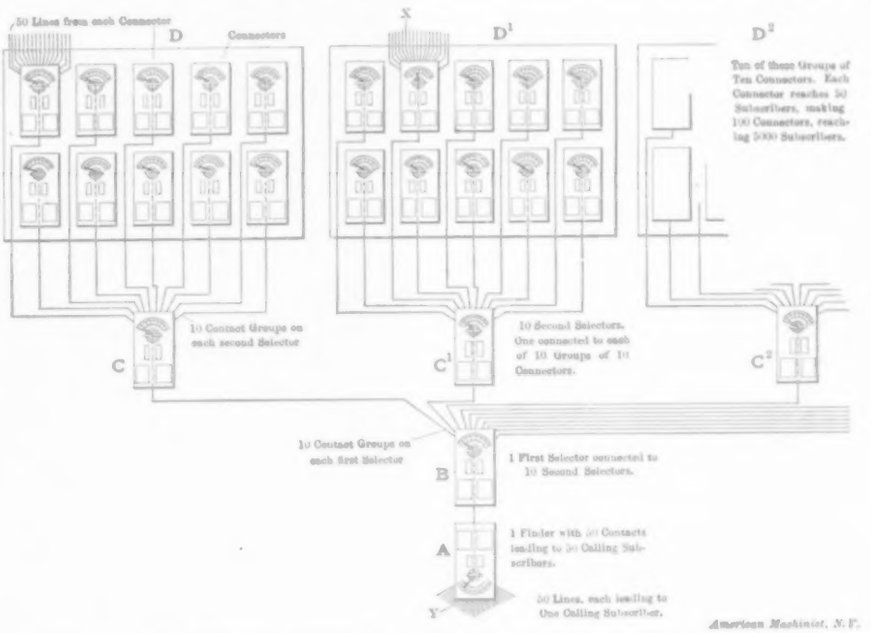

50 Lines from each Connector
D
Connectors
X
D¹
D²
Ten of these Groups of Ten Connectors. Each Connector reaches 50 Subscribers, making 100 Connectors, reaching 5000 Subscribers.
10 Contact Groups on each second Selector
C
10 Second Selectors. One connected to each of 10 Groups of 10 Connectors.
C¹
C²
10 Contact Groups on each first Selector
B
1 First Selector connected to 10 Second Selectors.
A
1 Finder with 50 Contacts leading to 50 Calling Subscribers.
Y
50 Lines, each leading to One Calling Subscriber.
American Machinist, N.Y.

FIG. 4. DIAGRAMMATIC LAYOUT OF AUTOMATIC SYSTEM FOR 5000 SUBSCRIBERS

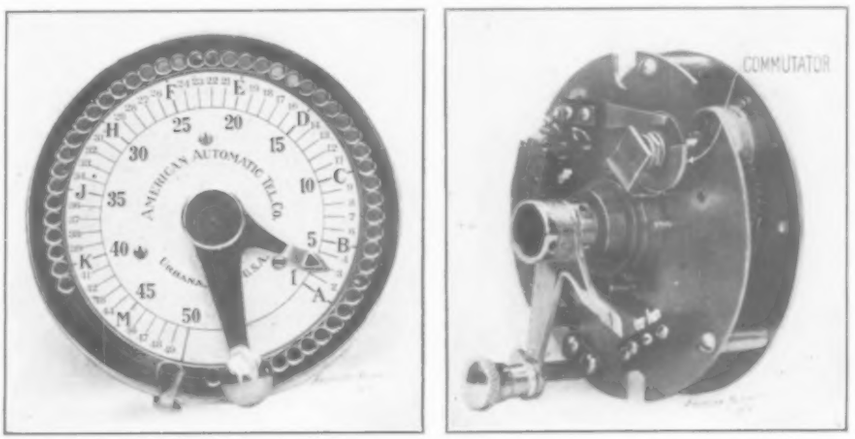


FIG. 3. CALLING DEVICE, WITH AND WITHOUT FRONT PLATE

With such a diagram as that shown in Fig. 4, allowing only one person out of 50 to talk to any one of 5000, and with the explanation of there being further switches for the use of other people who may be talking at the same time, the impression may be produced that the number of switches would necessarily be almost unlimited. This is, however, not correct, for with a system of, say, 5000 subscribers, any six of which in every 50, or 12 per cent., may be talking at the same time, there are required only 2400 instruments counting the finders, the first and second selectors and the final connectors.

For the purpose of illustration in this article, 5000 'phones have been assumed. It must not for a moment be supposed, however, that this is the practical limit to automatic operation. By the addition of further switches in direct proportion to the 'phones added, any number of 'phones may be automatically controlled.

The Central at Urbana, Ohio

The Independent Telephone Company, of Urbana, O., with 1500 subscribers, is now using a Central manufactured by the American Automatic Telephone Company and the perfection and certainty with which this central office operates is most astonishing. There appear to be no complaints on the part of the people using these telephones and there is no hesitancy in proclaiming the system an entire success. As already intimated, this automatic system allows six persons in every 50, or 12 per cent. to talk at one time. Ordinary manual practice gives only 10 per cent.

In the central office in Urbana there is a further provision made so that any subscriber in town on the automatic centrals, may by calling up a special selector switch by a suitable number of impulses, be connected directly to what are known as the "farmer switches." These farmer switches make connections to the various farmers in the surrounding country and when this connection has been made, by turning the calling device a longer or shorter distance, various code rings of a long and a short, or two longs and two shorts or a long and two shorts, or any other system of code ringing may be produced so as to call any desired farmer on a party line having, no matter how many instruments in series, depending upon the system in use. If a farmer wishes to call up a town subscriber, he rings up on his own magneto calling an operator in the central office. This operator has in front of her a calling device of the automatic system leading to all of the subscribers in town and by properly turning the lever of this calling device, as already described, she can pass the connection on to any one of the town subscribers to whom the farmer desires to talk.

This same principle of having an automatic system in combination with a manual operator enables extensions to be made to existing manual systems, as by putting a large number of automatic machines at the disposal of the manual operator any connection may be made from the automatic to the non-automatic parts of the service. This has been done in a number of instances resulting in very greatly extended possibilities for manual switchboards which had already reached their limit of growth. It should be remarked in passing that with a manual system, if the switchboard is entirely filled up, it is necessary before any further manual extensions can be made to entirely tear out that board and put in another one of larger proportions, because there are connections termed "multiples," located above the regular connections, which must be made whenever another panel of connections is added, and which it is impossible to put into the existing board. In this one feature of extension, the automatic device has an obvious advantage over the manual board, because in order to extend the automatic system, it is necessary only to add another bank of instruments without disturbing the connections of those already in.

Getting at the Switches

Another one of the principal features of these automatic devices is the fact that the switches of the central office are so designed that in case one of them should become deranged, it is necessary only to pull it out by hand and insert a duplicate switch in its place simply by pushing it in. This construction is shown at the right of Fig. 2. All the connections to the switches are made by means of "jacks," which push in and out in this way and it is not at all necessary to disturb the soldered wire connections at the back. In this way a couple of inspectors are able to take care of a very large installation by simply pulling out and replacing the various switches as it is found necessary to inspect them. If any one switch is defective, it may be repaired while a duplicate is in its place. This feature alone is of tremendous importance in such a thing as an automatic telephone central for it insures that the whole apparatus be in first-class working order, and that there is no necessity for any part of it to become out of order on account of the necessity of putting the whole board out of operation, or in fact, any part of the board, while repairs are made.

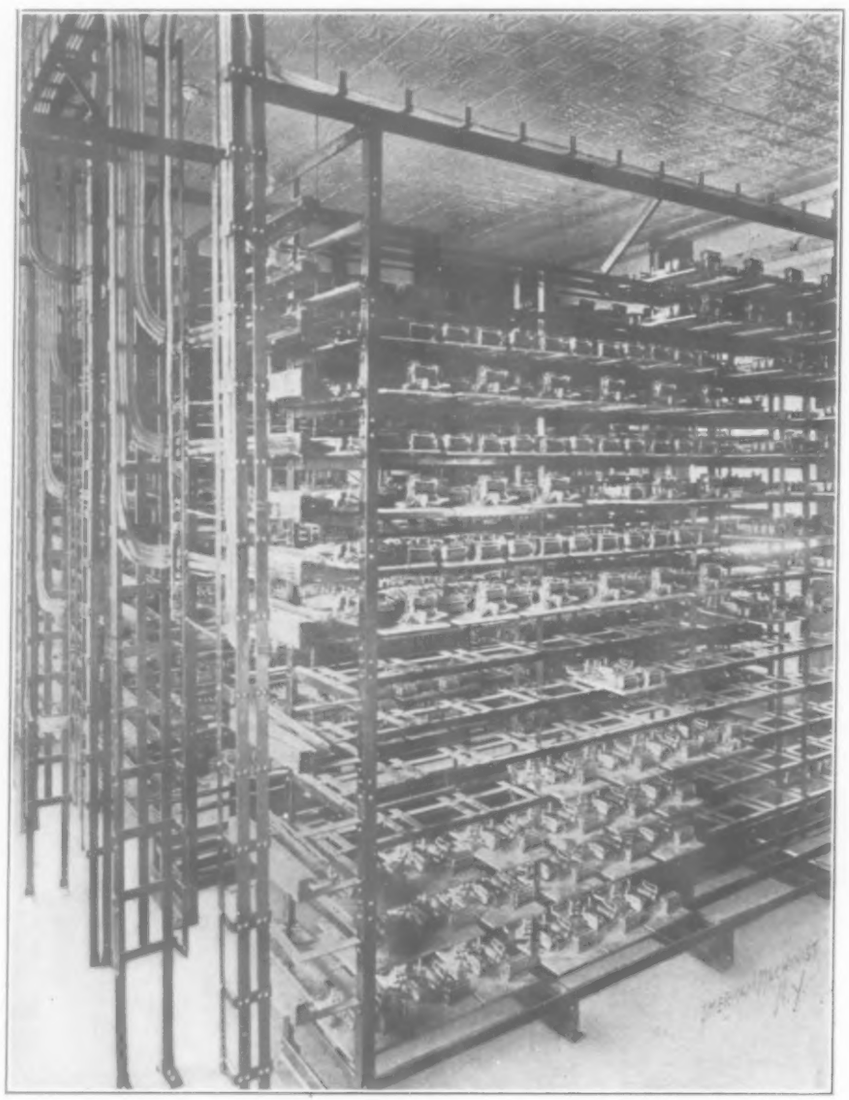


FIG. 5. AUTOMATIC SWITCHBOARD AT URBANA, OHIO, HANDLING 1500 SUBSCRIBERS

It should further be said that this system employs what is known as harmonic bell ringing, that is, with a party line of, say four subscribers it is perfectly possible to ring the bell only of the subscriber desired, while the other bells on the same line are silent.

Harmonic bell ringing is obtained by the use of alternating current for ringing, these alternating currents being of different frequencies. For four bells on a line there would be one generator giving a frequency of 16⅔ cycles per second, another of 33⅓, another of 50, and another

of 66⅔ cycles per second, and by the device of using bell clappers of various weights, only that clapper which would have a period of vibration corresponding to the period of impulses of the magnetism given to it by the alternating current of any one frequency will be caused to ring, the other clappers being of greater or less frequency of vibration than the magnetism, would not vibrate and so these bells would not ring.

Metered Conversation

At the present time in all telephone work, whether of the manual or automatic type, there is a desire for what is known as "metered" service, that is, the telephone to be paid for according to the number of minutes it is in operation. For this purpose the American Automatic Telephone Company has a complete system of metering devices which they have perfected and which they are ready to furnish as soon as required.

For private lines they have an arrangement in the central office driven by a motor which will add up the total number of minutes during the month that the telephone is in actual use, and the charges to the subscriber are based on the record of this meter. For pay-station service they have another motor-driven meter arrangement which is equipped with commutating contacts on several disks, these contacts being spaced at different intervals on the different disks and arranged in such a way that they will collect money at a rate proportionate to the price of the call and the length of time that the telephone is in operation. For instance, suppose a person wishes to telephone to a suburb, the price of the first three minutes, say, being 10 cents and each succeeding three minutes 5 cents. Into the hopper of a little box in the booth he places a number of nickels. By means of the regular calling device he can obtain the line of the person to whom he wishes to speak. As soon as the connection is made the metering device automatically drops 10 cents from the pile of nickels into the receiving part of the box. This does not happen, however, until the subscriber at the far end has answered the 'phone by taking off his receiver.

When the first three minutes are up the metering device by means of the disk contact in the central office, automatically takes another nickel and drops it into the bottom of the box. This allows the subscriber to talk for three minutes longer. At the end of the next three minutes another nickel is automatically dropped into the box from the pile in the hopper. When the conversation is ended and the receiver is hung up whatever money is left in the hopper is automatically dropped out into a tray and the subscriber may then put the change back into his pocket. If, while the conversation is going on, the supply of money in the hopper should give out, the connection through to the other 'phone is not lost, but the person at the far end cannot hear what is being said to him, although the person at the paying end can still hear and thus understand very quickly that his conversation is not being transmitted, this being the signal that he should drop more money into the hopper. As soon as the next nickel is dropped in the connection is made again so that both parties can hear and talk as usual. The connection not being entirely lost until the receivers are hung up, the trouble of calling a second time, in case the money should give out, is entirely avoided, and also it is not necessary to make another original payment of 10 cents as was done when the first connection was made.

In some districts it is customary to have a cheaper rate for night than for day service, and in order to take care of this there is a switch in the central office which may be turned by the wire chief after a certain time, say 6 o'clock in the evening, when the rate may be cut in half or into any other fraction; that is, the length of time allowed for conversation for one 5-cent piece is doubled or tripled, as the case may be. This again shows that there is no feature in connection with telephone service that cannot be taken care of by an automatic device.

It may be objected that this automatic metering system will make "too much money" for the telephone company because it very often happens that girls in the central office of a manual system forget to call for a second nickel. It is, however, more just to the subscriber as well, for everybody is treated exactly alike and especially so in the case of a private telephone where a short conversation does not cost as much as a long one, because of the use of the time-adding meter. In fact, it would seem that metered telephone service is just as desirable as metered gas service, for no gas consumer wishes to pay at a flat rate when he knows he is not consuming as much gas at one time as he is at another, or as much as his neighbor is, with the same number of jets.

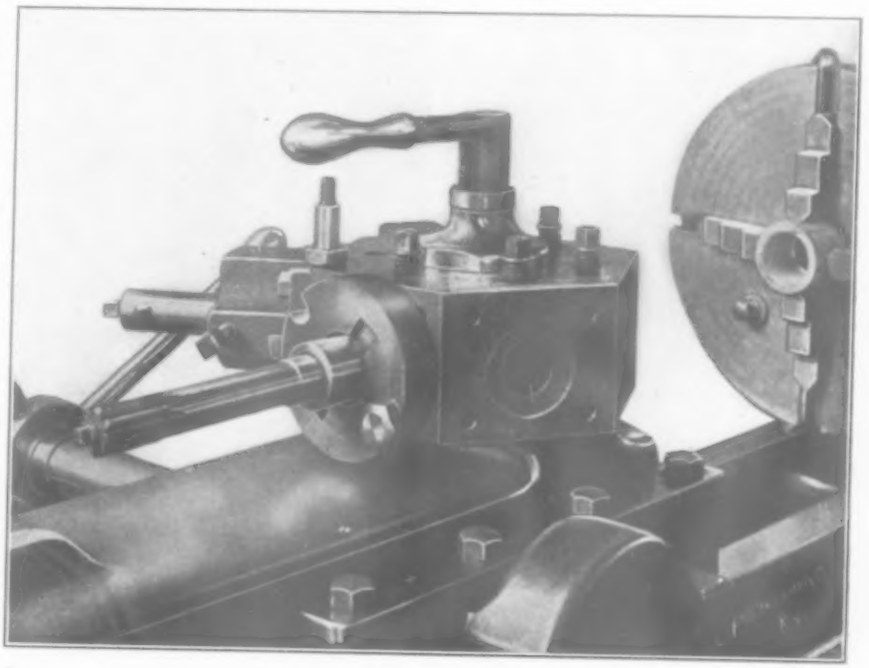
Fig. 5 is a view of the switchboard in the central office at Urbana. This switchboard handles 1500 subscribers, and the photograph shows the compact form in which the switches are arranged, and how easy of access they are for inspection and repairs.

It is thoroughly realized in the Middle West that the automatic telephone central is a thing of the very near future, and there is little doubt that in a few years all of the work which is now done by the manual centrals will be done by the automatic instruments.

Another Floating Reamer Holder

By E. A. Dixie

Floating reamers have been illustrated in the American Machinist before, but I have yet to see one handier than the one shown in the halftone. This was



A FLOATING REAMER HOLDER

designed by E. J. Armstrong, superintendent of the Ball Engine Works, Erie, Penn., where it is used in a Warner & Swasey turret lathe. It consists of an inner plate with lugs on either side engaging with the outer plate which is held loosely by the two shoulder screws, one of which is removed and is shown on top of the turret. The inner plate is provided with a taper socket, in this case Morse No. 3, so that any reamer with that size of shank can be used in it.

Liquid Gas for Welding and Lighting

Manufacture and Properties of the Gas, Its Uses for Welding, Lighting, Brazing, etc. Apparatus Needed and Mechanical Work It Will Do

BY E. F. LAKE

Liquid gas is the latest product that has been brought forward as a useful factor in the autogenous welding of metals. It is obtained by the distillation in retorts of various materials, such as heavy oils, paraffin oils, crude petroleum and all of its products and residue. The vapors and gases thus produced are then passed through a tar separator and cleaner, which removes any deleterious or malodorous by-products that may be present, as well as the easily condensable gases, such as tar, benzine, etc.

The above is the same process that is used in producing any of the oil gases. To it has been added a special process invented by L. Wolf, of Basseldorf, near Zurich, Switzerland. Mr. Wolf is shown welding the iron casting in Fig. 1. This special process, by the use of cold and pressure, separates the difficult liquefiable gases, such as hydrogen, methane, etc., from the more easily liquifiable ethane, propane, pentane, etc.

After the gas has passed through this special process it is charged into steel bottles at a pressure of from 1200 to 1500 pounds per square inch. This transforms it into a liquid, but when this high pressure is removed it immediately gassifies, and at the ordinary pressure of the atmosphere it is a dry inflammable gas.

Composition and Properties

The value of this process lies in the simple and inexpensive manner in which the gas is manufactured and liquefied, as this has made it a commercial product that can be sold and used in competition with other gases. It can also be charged into steel bottles at high pressure, the same as common carbonic-acid gas, or oxygen, and it can then be sold and shipped in this form.

Liquid gas is a mixture of hydro-carbons, and consists principally of ethylene and ethane, together with small quantities of methane and highly homoloques of ethane and a little benzole. Only traces, not amounting in all to 3 per cent., are present, of carbon dioxide and air, and no acetylene nor carbon monoxide is present; hence liquid gas is non-poisonous. This enables it to be used freely for welding or lighting without any injurious effects.

The limit of explodibility of liquid gas is fixed between a mixture of 96 per cent. of air to 4 per cent. of gas, and 92 per cent. of air to 8 per cent. of gas, which is a range of 4 per cent. Ordinary city coal gas has a range of explodibility of 13 per cent., which is from 6⅔ to 19⅔ per cent. of gas with the balance air, and the explosive range of acetylene is 49 per cent. Thus, liquid gas is three times less explodible than coal gas, and 12 times less than acetylene.

Specific Gravity and Heat of Gas

The specific gravity of liquid gas, as compared with air at 1000, is 1.027; hence it is heavier than air and mixes with it with difficulty, and this reduces the danger from explosion. A hotter flame can be produced by combining liquid gas with oxygen in a torch than with any of the other known gases. Thus the oxy-liquid gas flame develops 7000 degrees Fahrenheit, while the oxy-acetylene flame gives 6300 degrees and the oxy-hydrogen flame produces but 4800 degrees.

This is due to the fact that there are 2500 more thermal units per cubic meter in liquid gas than in acetylene gas. While the hydrogen flame is very wide and, therefore, loses much heat by radiation, the liquid-gas flame is short and pointed with a cone-shaped center, like the oxy-acetylene flame. In using the gas it is bought from the manufacturer in a liquid state in steel bottles at a cost which about equals that of coal gas at $1 per thousand feet.

Welding Apparatus

In Fig. 1 the apparatus for welding is shown as used to weld a cast-iron sprocket wheel. The gas can also be piped from this same apparatus for any lights that are needed. The reflector shown on the pipe leading from the expansion tank, and above said tank, is for a limelight that was being exhibited as one of the uses for this gas.

The gas bottle *A* is connected to an expansion tank *B* by the piping *C*, as is best shown by the enlarged view of the gas apparatus in Fig. 2. When the gas is wanted it is allowed to flow into the expansion tank, by opening the valves *D* and *E*, until any pressure desired up to 60 pounds per square inch has been reached. The valves *D* and *E* are then closed and the gas used out of the expansion tank. If the 60 pounds pressure should be exceeded the gas will escape through the safety valve *F*.

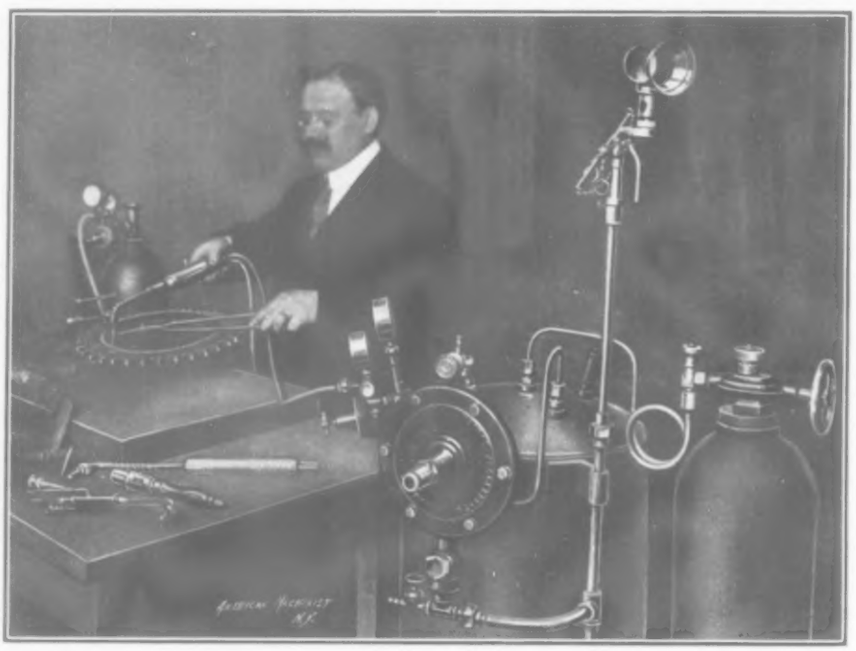


FIG. 1. THE APPARATUS USED WHEN WELDING

An automatic pressure regulator *G* is also supplied with the tank. The pressure indicator *H* will show when the tank needs refilling.

When the gas is expanding from its liquid state in the bottle *A* and flowing through the pipe into the tank *B*, the pipe *C* is covered with frost, which shows the refrigerating properties of the gas.

The pipe *I* is for the limelight, shown

in Fig. 1, but gas for ordinary lights can be carried around the room from the same pipe.

The only other things that are necessary for welding are torches and oxygen. The oxygen is taken from the bottle to the right of the operator in Fig. 1, and the torch is shown in his hand.

A small portable gas outfit for welding, brazing, lighting, or any other use desired, is shown in Fig. 3. This is but 2 feet in length over all and can be easily carried on a man's back while he is handling the torch and doing the welding. It is supplied with a pressure regulator, safety valve and pressure indicators the same as the larger sizes.

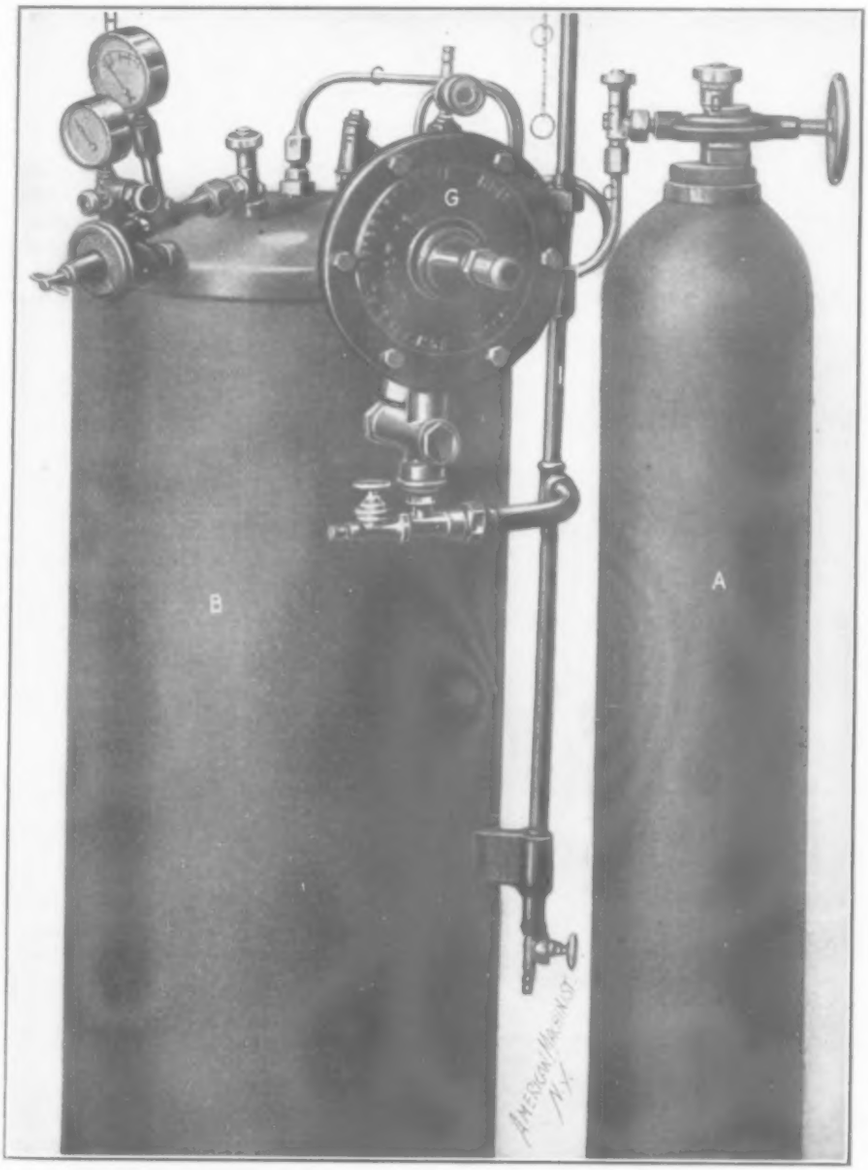


FIG. 2. LIQUID GAS APPARATUS AS USED FOR LIHGTING OR MILLING

Welding Torch

The welding torch that is used with liquid gas is much simpler than those used for oxy-acetylene welding, as there is no danger of backfiring owing to the very low explosive properties of the gas. This does not make it necessary to add any mechanism to the torch to prevent backfiring.

The welding torch is shown by *E* in Fig. 4. It consists of an air chamber in the end for the purpose of keeping the the handle cool. This it does perfectly as the torch can be kept in operation for hours at a time without any sign of overheating. Thus it is not necessary to keep two torches in operation so that one can be cooling off while the other is being used.

The gas and oxygen are passed through this air chamber from the rubber hose into the mixing chamber, which occupies the front half of the body of the torch. At the rear of this chamber the gas is carried out through a pipe that is coiled around the stem of the torch. This is for the purpose of warming the gas before it is used. Oxygen passes out of the forward end of this chamber through another pipe that meets the gas pipe at the nozzle of the torch. Through the central stem is carried the mixed gas, and the three are all combined at the nozzle, thus forming a good mixture for combustion.

With this torch but three tips are needed for welding or cutting any kind or thickness of metal. The three sizes of tips are shown by the one on the torch *E* and by the two tips at *I* and *J*.

Cutting Torch

The oxy-liquid-gas torch for cutting metals is shown at *D*, Fig. 4. When cutting metals it is not necessary to coil the pipe around the stem to warm the gas, and, therefore, the gas and oxygen are piped into the mixing chamber and carried out through the stem to the work.

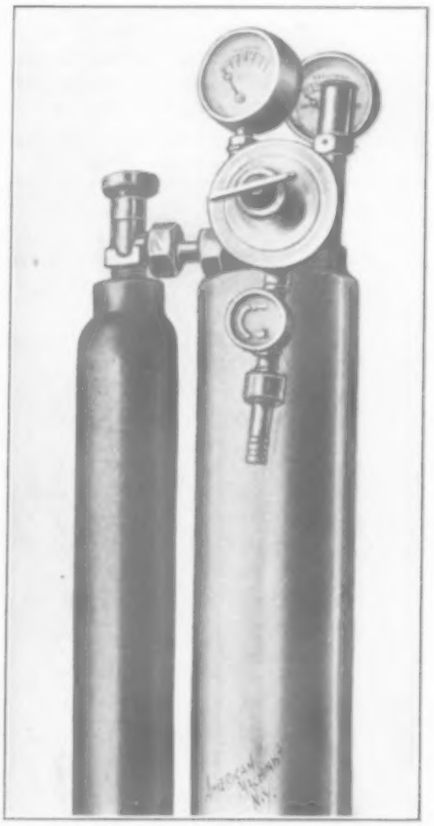


FIG. 3. PORTABLE GAS APPARATUS

As with other torches, an extra jet of oxygen is necessary when cutting metals to localize the heat and remove the burnt products. The lower tube on this torch carries the extra jet of oxygen to the work and makes it strike just ahead of the flame.

Cocks are located on the gas and oxygen pipes, immediately behind the torch so that they can be opened or closed by the thumb or fingers while holding the torch and cutting the metal with it. This makes it a very handy torch, as the liquid

gas and oxygen can be regulated without stopping work.

The forked piece that is clamped to the stems of the torch, near the nozzles, is for the purpose of guiding the torch while cutting. Thus the two prongs of the fork can be made to rest on the work, which will bring the flame the right distance from it, and the side of either prong can be moved along a straight-edge or former, so as to cut the work in any shape desired.

Samples of Metal Cut

It is said that steel and iron up to 14 inches in thickness have been successfully cut with this process at the works in Switzerland. There is practically no loss of metal in cutting it in this manner, as the cut is no wider than would be made with a saw, and the metal is not perceptibly heated on either side of the cut. Steel 2 inches wide and ¾ inch thick can be perfectly cut in less than a minute and cuts in thicker metal are made in so short a time as to be almost unbelievable.

Some cutting that has been done with this process is shown in Fig. 5 at about its full size in order to show the exact width and smoothness of the cuts.

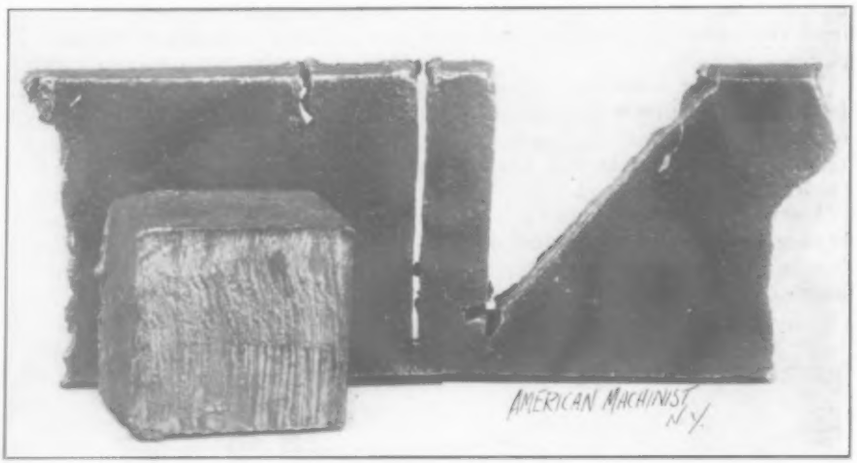


FIG. 5. SAMPLE OF CUTTING DONE WITH LIQUID GAS

The large piece is ½ inch thick and 1¾ inches wide. Both ends have been cut an irregular shape. A V-shaped piece of metal has been cut out, and the piece nearly cut in two, to show the width of the cut. This cut is but 1/16 inch at the top edge where it was started and when the torch got to work properly it was reduced to 1/32 inch. On the bottom side of the piece the cut widens out slightly, but in no place was it over 1/16 inch in width. The smoothness of these cuts can be seen by an inspection of the right-hand side of the V-cut.

The small piece is 1⅛ inches square and shows the surface of the metal where it has been cut off. For this thick cut the metal did not show any signs of heating ⅛ inch back from the edge on the under side, and at the top of the cut it was apparently good metal less than 1/16 inch back from the edge.

This cut was made with an oxygen pressure of 40 pounds and without a guide, which, if used, would have made even a smoother cut. The cut was made in 27 seconds. Other cuts were made at the same time on metal that was 1½ and 1¾ inches thick and but one bottle of oxygen was used.

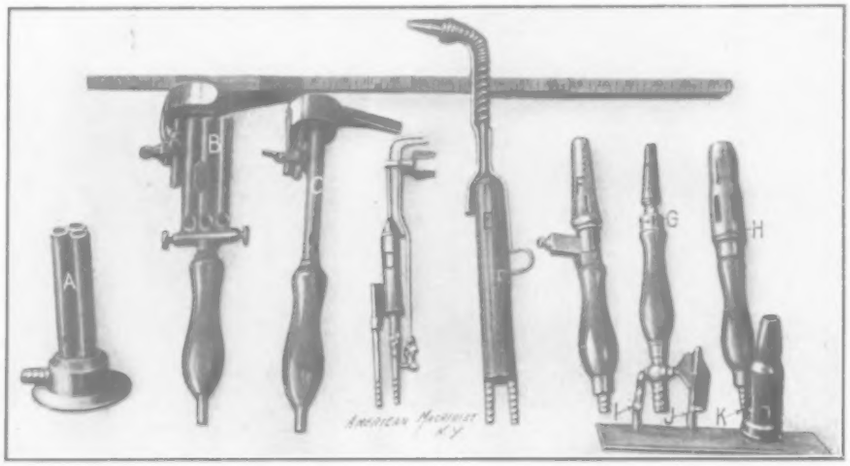


FIG. 4. SOLDERING, WELDING AND BRAZING TORCHES FOR LIQUID GAS

Soldering and Brazing

Liquid gas is also useful for soldering and brazing, and for this kind of work no oxygen is needed. In Fig. 4, *A* is an ordinary Bunsen burner that will develop heat enough, with liquid gas, to melt small brass wire, or thin sheet metal. *B* and *C* are soldering coppers with single and triple burners. These can be made with any number of burners desired to heat any size of copper that is required. At *F*, *G* and *H* brazing torches are shown.

The brazing torches are made with interchangeable tips that will produce any size of flame desired, and *K* shows one of these tips. The handles, however, are so inexpensive that it will doubtless pay to have a separate handle for each tip. For paint scrapers, plumbers' tools and many other things of a similar nature that require heat, similar torches are fitted up. This is due to the fact that a day's supply of gas can so easily be carried around in the portable outfit.

Various Samples of Welding by Liquid Gas

In cast-iron welding the sprocket wheel that was being welded in Fig. 1, is shown before and after it was welded, in Fig. 6. This broken piece was welded in so that it fitted the chain as well after it was repaired as it did before it was broken. In Fig. 7 is shown a broken pulley be-

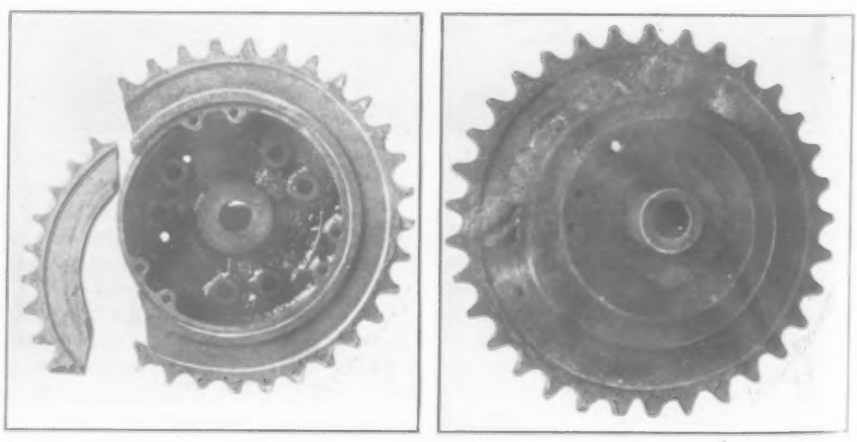


FIG. 6. AUTOMOBILE SPROCKET BEFORE AND AFTER WELDING

fore and after welding. This pulley was practically smashed to bits, but it was repaired and is now in daily use. While it might have been as cheap to get a new pulley cast it would have taken at least a day to get a new one cast and machined, or shipped from the factory. This one, however, was welded and put back in use in less than 2 hours.

In Fig. 8 is shown a steam blow-off

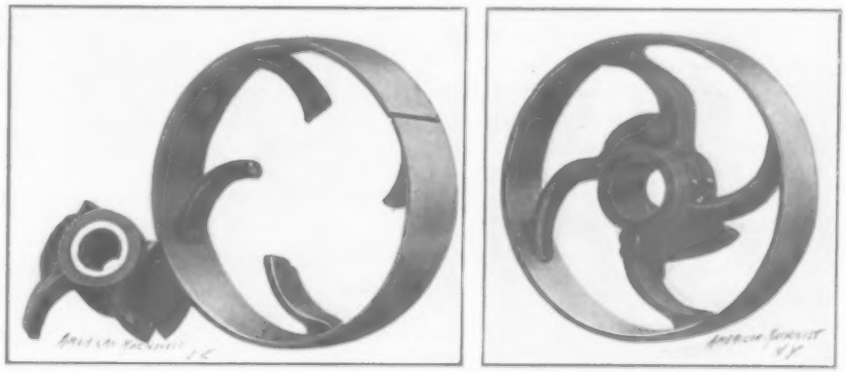


FIG. 7. BROKEN PULLEY BEFORE AND AFTER WELDING

valve that was allowed to freeze and crack open. The crack was welded and the valve is now in use, doing as good service as before the break. While these samples show only cast-iron welds, steel is welded more successfully, as it is much easier to weld than cast iron by the autogenous processes that develop even less heat than this one. Brass, bronze, aluminum and other metals are also welded satisfactorily with this process.

Applicability to Lamps for Lighting Purposes

Liquid gas also has a wide field as a lighting proposition. Owing to the fact

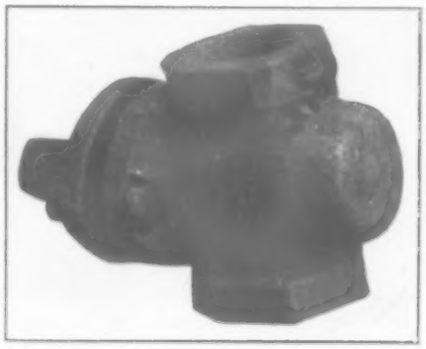


FIG. 8. CRACKED VALVE AFTER WELDING

that it is shipped in steel bottles, the same as carbonic-acid gas or oxygen, it is very useful for lighting shops that are located away from a gas supply, as well as for any other kind of a building, or for outside lighting. It is also useful for lighting vehicles such as automobiles, busses, carriages, etc.

The lamps shown in Fig. 9 are designed for shop, hall and outside lighting. Lamp *X* is a 50-Hefner candle-power that is built very strong, and to withstand snow, sleet or rain. The cost of the gas to maintain it is ¾ of a cent per hour. An inverted mantle of small size is made especially for and used in the lamp.

Lamp *Y* is a 250-Hefner candle-power lamp of the same construction. It has two horizontal mantles resting on clay fingers and the gas lights the under part only of the mantle. A pilot light is kept burning in the lamp so that one or any number of lamps can be lighted from a central point. The cost of running this lamp is approximately 2½ cents per hour.

Lamp *Z* is 100-Hefner candle-power, with three tips projecting toward the mantle. The idea of this is to throw pure jets of air against the mantle and thereby get a very white light with a low consumption of gas. This light is operated at a cost of about 1 cent an hour.

Smaller lamps and simple gas jets are also used with this gas, the same as with ordinary city gas, but the opening in the tips should be much smaller than in those used for city gas. No change in the ordinary gas fixtures nor in the piping is necessary, but if new piping is put in a smaller size can be used.

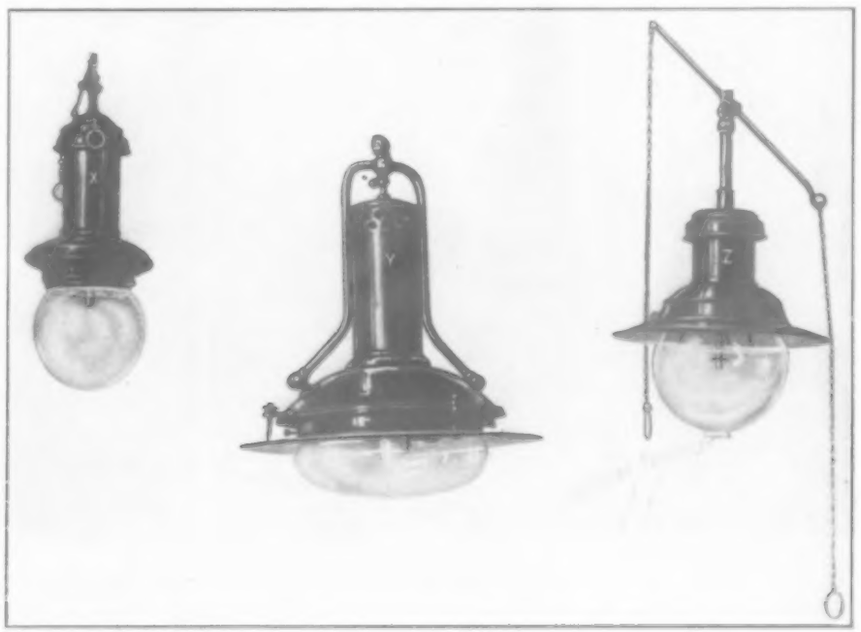


FIG. 9. THREE TYPES OF LIQUID-GAS LAMPS FOR SHOP USE OR STREET-LIGHTING PURPOSES

Additional Facts Concerning Properties of Liquid Gas

As liquid gas is not affected in any way by the outside atmosphere, the apparatus can be located in any convenient place whether it be inside or outside of the building. The gas pipes cannot become choked as no water can be deposited in them.

Liquid gas or its products of combustion do not attack metal, hence the burners, torches and fittings last a long time. This also is of special benefit in the welding of metals as it does not injure the metal in the joint and good strong welds are the result.

It is of interest to note that Count Zepperlin is using this gas in his balloon shed for lighting as well as welding. He has the largest expansion tank that has so far been built and keeps 5 men constantly at work at welding.

The smallest work that the gas is used on is in welding watch parts together in some of the Swiss factories.

The liquid gas is manufactured and stored in steel bottles for shipment by the Liquid Gas Company of Massachusetts, Danvers, Mass. L. Wolf, the inventor of the process, has located in Boston and is the consulting engineer of the company.

There are at present in use or being built plants for the electric refining or manufacture of steel having a combined capacity of 150,000 tons per annum.

Fire Control Towers for Battleships

By Charles B. Brewer

The battleship fleet has returned from its world-encircling voyage of 43,000 miles, and the reports covering its itinerary include in one breath the waters of the north and south Atlantic, north and south Pacific and the Indian oceans; the Red sea, the sea of Japan, and the Mediterranean sea.

It may be remarked, with just pride by all Americans, that repairs in the true sense of the word which are necessary to our vessels after such an unprecedented cruise are astonishingly few in number, and that work on the vessels will practically be confined to the installation of improvements; either those developed during the absence of the vessels or found necessary by the extended voyage with its target practices, fleet evolutions, etc. The lack of necessity for repairs of any moment has served to show the "stuff" of which our ships are made and how efficiently they were put together.

When the vessels again go to sea in June, for the spring target practice, they will present an almost strange appearance to eyes familiar with vessels of the fleet as they used to be.

One of the many alterations or improvements with which most of the battleships will be fitted on the present visit to their home yards is the "fire control tower." The military masts, pilot houses, bridges, and other "top hamper," will give way to the fire control towers, or "cage masts" as they are popularly known. The other changes will be emphasized by the "war color," a dull gray, which will henceforth replace the white of hull, and the straw-colored trimmings so long familiar to the ships.

This dull slate color will completely cover the ship, except for distinguishing bands of white, three feet wide, on the funnels to mark the division to which the vessel belongs and the identity of the vessel itself. The first smokepipe marks the division. The vessels of the first division are not even allowed the band of white; those of the second have one band; of the third, two; of the fourth, three. Similarly, the second smokepipe has none, or is marked with one, two or three bands to mark the first, second, third or fourth vessel of a division.

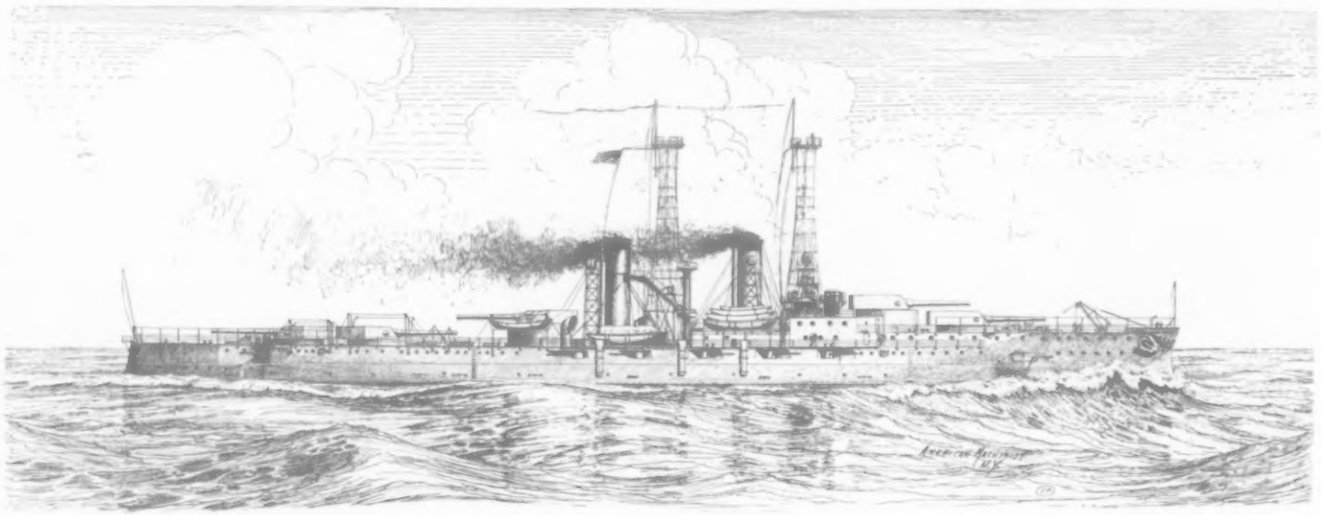


FIG. 1. BATTLESHIPS "DELAWARE" AND "NORTH DAKOTA" AS THEY WILL APPEAR WITH FIRE CONTROL TOWERS

FIG. 2. FIRE CONTROL TOWER OF BATTLESHIP "MISSISSIPPI" DURING ERECTION

Fire-control Towers

The primary purposes of these fire-con-

trol towers is to provide a platform as high as practicable from which the fire-control party may observe the splash of the projectiles as they fall, miles away, and be able to advise the gunners, as the battle begins, whether they are firing beyond or short of the target.

The towers are about 90 feet high (above the deck) and the top platform will stand 120 feet above the water line, the limit which will pass under Brooklyn bridge. They are 26 feet in diameter at the base and 12 at the top. The graceful lines and delicate appearance of the structures, designed expressly for lightness, do not suggest their strength and rigidity. Every vertical element extends continuously from top to bottom and is a straight line to develop the full strength of the material. The curved outline of the tower is the result of twisting the top ends of the vertical members 90 degrees from their bottom ends to furnish strength and readily afford means of thoroughly tying the structure together. The figure is known as a hyperboloid of revolution.

The numerous vertical elements are composed of seamless drawn steel tubing, the lower ones somewhat larger than the upper ones. All members are rigidly clamped together where they pass each other. The fittings are drop forgings and steel castings. There are several platforms of wire-mesh to afford a walking space around the standard compass, searchlights, etc. The access hatches through these platforms are staggered to prevent objects, accidently dropped, or men, from falling any great distance.

The structure has shown itself wonderfully rigid and free from vibration on the tests to which sample towers were subjected.

On a model of the tower a test of the strength was made by cutting a large proportion of vertical members, and afterward a still larger proportion (actually more than the full number of parts, by cutting some in more than one place) and the tower still remained self-supporting. On a testing machine the model showed itself good for more than six times the strains to which it will be subjected.

The first sample full-sized tower was put on the Monitor "Tallahassee" (formerly the "Florida") and built with a rake of 10 degrees. This was subjected to firing tests last summer at the time the turrets of this vessel furnished an experimental target. The vessel was also torpedoed experimentally at the same time.

FIG. 3. BATTLESHIP "IDAHO" WITH COMPLETED FIRE CONTROL TOWER

The towers were tested for rigidity, etc., on the recent trip of the "Idaho" and "Mississippi" to Guantanamo. A Naval Constructor was detailed to each vessel to observe and report on the efficiency of the towers.

One of the last acts of Mr. Newberry, as Secretary of the Navy, was to order twenty of these towers placed on different battleships. Two for each ship are to be placed on the "Connecticut," "Louisiana," "Kansas," "Vermont," "New Jersey" and "Georgia;" and one each on the "New Hampshire," "Minnesota," "Nebraska," "Rhode Island," "Virginia," "Missouri," "Wisconsin" and "Ohio.' A second tower will be fitted to each of the last-named vessels when opportunity offers.

The cost of the towers will be about $5500 each for labor and material. The weight of each tower is about 16,000 pounds. The effect on the stability of the vessels is inappreciable.

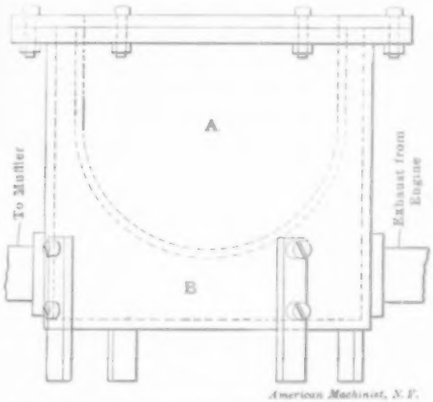
The celebrated British "Dreadnought" was the first battleship to depart from the usual military mast. It was fitted with a fire-control tower resembling a three-legged stool, the members being connected at the top only. The development of the tower here described is due to the ingenuity of members of the technical staff of the Navy Department, the idea being suggested by a woven-wire waste paper basket.

In order to have the towers ready for the spring target practice, the orders for material were divided between the National Tube Company and Seamless Tube Company of America. The steel castings are to be made at the navy yard, New York; the drop forgings at the Norfolk Navy Yard, and the ladders and platforms at the Philadelphia Navy Yard, where the towers of the "Mississippi" and "Idaho" were built. Certain of the vessels will receive their towers at these yards and the remainder at the navy yards at Boston and Portsmouth, New Hampshire.

Heating Soda Tank with Gas Engine Exhaust

By B. H. W. Schultheiss

The line cut shows how one shop man utilized the waste heat from the gas engine to heat the soda tank for cleaning chips and oil from cutters, etc. The tank



HEATING SODA TANK WITH GAS-ENGINE EXHAUST

A is of cast iron 11 inches diameter by 10 inches deep.

Bolted inside the box casting *B* which is 13½ inches diameter by 13 inches deep. *B* is ⅝ inch thick and tapped for exhaust pipe. It is situated as shown between the engine and the muffler. This arrangement was very satisfactory. The water evaporates very rapidly unless a cover is used.

Current Practice in Steam-engine Design*

Compared with 10 Years Ago, There Is Greater Uniformity in Design, a Reduction in Weight per Horse-power, Showing Better Workmanship, Etc.

BY OLE N. TROOIEN

This investigation was undertaken for the purpose of adding a little information to the present knowledge of current practice in proportioning steam-engine parts.

A similar investigation was undertaken at Cornell University 10 years ago, and by comparing the two results, the trend of progress in the design of steam engines during the last decade may be observed.

Practice in proportioning standard steam-engine parts has settled down to certain definite values, which have by long usage in actual operation been found to give good and satisfactory results. This general agreement is found to exist, not only in different engines made by one manufacturer, but also in engines made by different manufacturers as well. These values are of such a nature that they can readily be expressed in a formula, showing the relation between the more important factors entering the problem of design.

Although these formulas are not always mathematically exact, still they show in an approximate way the relation between the more important variables to be considered in proportioning engine parts. They may be considered as partly rational and partly empirical; rational in the sense that the variables enter in the same manner as in a strictly analytical analysis and empirical in the sense that the constants, instead of being obtained from assumed working strength, bearing pressures, etc., are derived from actual practice and include elements whose values are not accurately known but require consideration which is given by assigning values that have been found to be safe and economical.

The formulas here given at least show the general trend of practice and in some cases will serve as a check upon the "engineering sense" and good judgment of the designers.

Method of Procedure

In order to carry out successfully an examination of this nature, it was first necessary to secure data as to dimensions and weights in actual use which had proved satisfactory in practice. This required a coöperation of the builders of the engines examined, and in order to better secure this coöperation, printed forms, containing about 150 questions concerning the different engine parts were sent to the builders of the classes of engines examined. A printed circular stating the plan and object of the undertaking was also included as well as a personal letter.

As was expected the matter of collecting this data presented some difficulty and although all the engine builders communicated with did not see fit to furnish the desired information, still data covering a large number of engines and representing many different builders were secured. This information represented sizes varying from 20 to 400 rated horsepower and the data secured were first tabulated and separated into classes and subclasses, the two main classes being high-speed or quick-revolution engines and low-speed or slow-revolution engines (the latter class being principally the Corliss). Divisions into subclasses were made in the treatment of such parts as the crank pin for center-crank and side-crank engines, while in dealing with such parts as the piston rod or crosshead pin, no such division was thought necessary.

The following symbols of notation are used in the formulas given:

D = Diameter of piston.
A = Area of piston.
L = Length of stroke.
p = Unit steam pressure, taken as 125 pounds per square inch above exhaust as a standard pressure.
$H.P.$ = Rated horsepower.
N = Revolutions per minute.
C = A constant.
K = A constant.
d = Diameter of unit under consideration.
l = Length of unit under consideration.

The commercial point of cut-off was taken at ¼ of the stroke.

All dimensions are given in inches unless otherwise indicated.

Other notation than the above is explained as used.

The general method employed in deriving the various expressions and in plotting the curves shown in the cuts (usually straight lines) may be illustrated by referring to the method used in obtaining the formula for the piston-rod diameter and in deriving values of the constants used.

Piston Rod

It was deemed best in this case to treat the piston rod as a long strut, to be designed for rigidity, inasmuch as any considerable buckling or flexure would be very objectionable, and a slight increase in diameter, due to this method of treatment, would only add to the factor of safety. Euler's formula for long columns was used. It has the form

$$P = K \pi^2 \frac{E I}{L^2},$$

in which E = modulus of elasticity; I = moment of inertia for the section; L = the length of the strut (in this case the free length of the piston rod); and P = the greatest load consistent with stability. The value of the constant K depends upon the end conditions of the strut, as to whether they are fixed or pivoted, free or guided. In this case the piston rod was considered as fixed at one end and free at the other, because some forms of guides are poorly adapted to resist lateral flexure. Here

$$K = \tfrac{1}{4},$$

or

$$P = \frac{\pi^2}{4} \frac{E I}{L_1^2},$$

L_1 = *length of rod.*

$$P = p \frac{\pi}{4} D^2; \quad I = \tfrac{1}{64} \pi d^4;$$

L_1 (in plotting) was taken equal to the length of the stroke L. This will merely change the constant in the final result. In plotting it was found that

$L_1 = 1.8\ L$ *for high-speed engines and* $L_1^2 = 3.2\ L^2$,

$L = 1.4\ L$ *for low-speed engines and* $L_1^2 = 1.96\ L^2$.

Assuming p as a standard steam pressure of 125 pounds per square inch and that $E = 30{,}000{,}000$, the Euler formula will take the following form for high-speed engines (with $L_1^2 = 3.2\ L^2$):

$$125 \frac{\pi D^2}{4} = \frac{\pi^2 \times 30{,}000{,}000 \times \pi \times d^4}{4 \times 3.2\ L^2 \times 64}$$

or

$$d^4 = \frac{125 \times 64 \times 3.2}{\pi^2 \times 30{,}000{,}000} D^2 L^2;$$

therefore,

$$d = 0.96 \sqrt{D L}.$$

In a similar manner for low-speed engines (taking $L_1^2 = 1.96\ L^2$),

$$d = 0.085 \sqrt{D L}.$$

Both of these expressions are for a factor of safety of unity. The equation used in plotting is

$$d = C \sqrt{D L}.$$

*Condensed from *Bulletin No.* 252 of the University of Wisconsin.

[The condensation consists mainly in omitting the plotted charts, of which Figs. 1 and 2 are typical.—Ed.]

In plotting the curves for the diameter of the piston rod for these two classes of engines, values of d were used as ordinates and values for $\sqrt{D\,L}$ for the same engine were used as abscissas.

Points located in this way are indicated by small circles in Figs. 1 and 2, and where two or more points derived from different engines coincide, a double circle is used. All points obtained from the engines of one maker are connected by a conventional line. The broken character of most of these lines is largely accounted for by the fact that sizes usually run in even fractional increments not less than 1/16 inch, and are usually more, and it is also due to such commercial considerations as using the same size of frame, pins and rods for different-sized cylinders and speeds.

A heavy full line is drawn to represent the average of the observations. Lines are also drawn to embrace the extreme points.

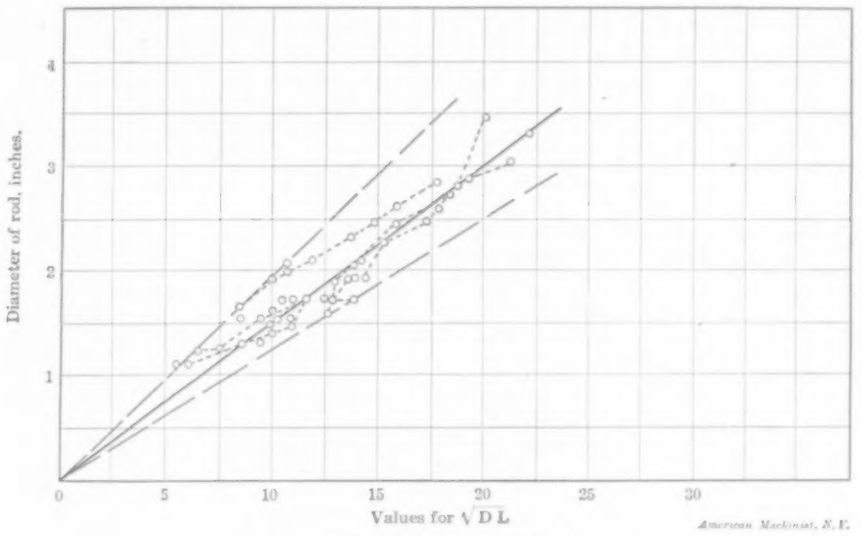


FIG. 1. PISTON ROD HIGH-SPEED ENGINES

From the equations of these lines different values of C are obtained which represent the average, maximum and minimum values of practice, as shown by the engines examined.

Piston rods of high-speed engines, Fig. 1:

Mean value of $C = 0.15$,
Maximum value of $C = 0.187$,
Minimum value of $C = 0.125$.

Piston rods of low-speed engines, Fig. 2:

Mean value of $C = 0.114$,
Maximum value of $C = 0.156$,
Minimum value of $C = 0.1$.

As the strength of a long strut varies as the fourth power of the diameter, it is necessary to compare the mean value of C, here obtained, with that obtained with a factor of safety of unity in order to get the true factor of safety. This is found to be

$$\left(\frac{0.15}{0.096}\right)^4 = 6$$

for high-speed engines, and

$$\left(\frac{0.114}{0.085}\right)^4 = 3.25$$

for low-speed engines.

Cylinder—The Thickness of Cylinder Wall

Theoretically the thickness of a thin cylindrical shell is proportional only to the pressure which it has to sustain, and the internal diameter of the shell. In the case of the cylinder wall of a steam engine, this thickness is modified somewhat in order to allow for reboring, and in small engines it is increased still more in order to insure good castings.

Several methods of expressing this thickness were tried, but none give any better satisfaction than the empirical formula used by Unwin. It has the form

$$t = C\,D + B,$$

where t = the thickness of the cylinder wall; D = diameter of piston, and C and B are constants.

From the engines examined it was found that $B = 0.28$ inch,

Mean value of $C = 0.054$,
Maximum value of $C = 0.072$,
Minimum value of $C = 0.035$.

No characteristic difference was found to exist between high-speed and low-speed engines.

Diameter of Stud Bolts

The diameter of stud bolts used for the cylinder cover may be expressed by the formula

$$d = C\,D + B,$$

when d = diameter of bolts; D = diameter of cylinder, and C and B are constants.

The mean value of $C = 0.04$ and $B = \frac{3}{8}$ inch.

With only one exception the smallest diameter of bolts used in the high-speed engines was ¾ inch, and in the Corliss engine the smallest value was 1 inch.

The mean thickness of cylinder flanges for holding cylinder covers, where these were bolted to cylinder flanges, was found to be 1.12 times the thickness of cylinder wall, for both high-speed and Corliss engines.

The thickness of cylinder cover at center seems to vary a great deal, but for the engines examined it may be taken as 2.75 times the thickness of the cylinder wall for high-speed engines and 1.12 times the thickness of cylinder wall for Corliss engines.

The number of stud bolts used for cylinder covers may roughly be expressed by

$$N = C\,D,$$

where N = the number of bolts,
Mean value of $C = 0.72$ for high-speed engines,
Mean value of $C = 0.65$ for Corliss engines.

The least number of bolts used for any engine was found to be six.

Clearance Volume of Cylinder

The clearance volume was found to vary from 5 to 11 per cent. in high-speed engines and from 2 to 5 per cent. in Corliss engines.

Ratio of Stroke to Cylinder Diameter

Ratio of length of stroke to diameter of cylinder in engines having a speed greater than 200 revolutions per minute:

$L = C\,D$,
Mean value of $C = 1.07$,
Maximum value of $C = 1.55$,
Minimum value of $C = 0.82$.

Ratio of length of stroke to diameter of cylinder in engines having a speed between 110 and 200 revolutions per minute:

$L = C\,D$,
Mean value of $C = 1.36$,
Maximum value of $C = 1.88$,
Minimum value of $C = 1.03$.

Ratio of length of stroke to diameter of cylinder in engines having a speed less than 110 revolutions per minute (Corliss engines):

$L = C\,D + B$,
$B = 8$ inches,
Mean value of $C = 1.63$,
Maximum value of $C = 2.40$,
Minimum value of $C = 1.15$.

Piston—Face of Piston

The relation existing between the width of the face of piston and the diameter of the piston can be expressed equally well in two ways:

By $w = C\,D$,
Or by $w = C\,D + B$,

where w = width of piston; D = diameter of piston; and C and B are constants.

Using $w = C D$

gives for high-speed engines:

A mean value of $C = 0.40$,
Maximum value of $C = 0.47$,
Minimum value of $C = 0.30$.

For Corliss engines:

Mean value of $C = 0.32$,

Using the equation $w = C D + B$

gives for high speed engines:

$B = 1$ inch,
Mean value of $C = 0.32$,
Maximum value of $C = 0.40$,
Minimum value of $C = 0.24$.

For Corliss engines:

$B = 1$ inch,
And mean value of $C = 0.26$.

The box type seems to be the prevailing form of piston. The thickness of shell of piston in high-speed engines is about 0.6 of the thickness of cylinder wall, and for Corliss engines this ratio is about 0.7.

Piston Rings

The prevailing number of rings used for the piston is two, and the rings are usually turned to a diameter ¼ inch larger than the bore of the cylinder.

Piston Speed—High-speed Engines

Mean piston speed = 605 feet per minute,
Maximum piston speed = 900 feet per minute,
Minimum piston speed = 320 feet per minute.

Piston Speed—Corliss Engines

Mean piston speed = 592 feet per minute,
Maximum piston speed = 800 feet per minute,
Minimum piston speed = 400 feet per minute.

Crosshead—Crosshead Shoes

The crosshead shoes are usually designed to withstand a certain unit bearing pressure, and this pressure is necessarily proportional to the pressure on the piston. The area of the crosshead shoes which sustains the vertical component of the force transmitted through the connecting rod may be expressed by the equation

$$a = C A.$$

The maximum pressure S on the crosshead (if the steam follows up for half stroke) is nearly equal to

$$\frac{r}{L_c} \times P = S = s\,a,$$

$$s\,a = \frac{1}{n} \times p\,A,$$

$$a = \frac{p}{n\,s}\,A = C\,A,$$

where S = total pressure on crosshead shoes; s = unit pressure on crosshead shoes; a = area of crosshead shoes; r = length of crank; L_c = length of connecting rod.

The unit pressure on the crosshead shoes may be found as follows:

$$s\,a = \frac{p\,A}{n},$$

$$s = \frac{p\,A}{n\,a} = \frac{p\,A}{n\,C\,A} = \frac{125}{n\,C},$$

$$n = \frac{L}{r}$$

may be taken as 6 for high-speed engines, and 5.5 for Corliss engines. The value of C was found to be the same for both the high-speed and Corliss engines:

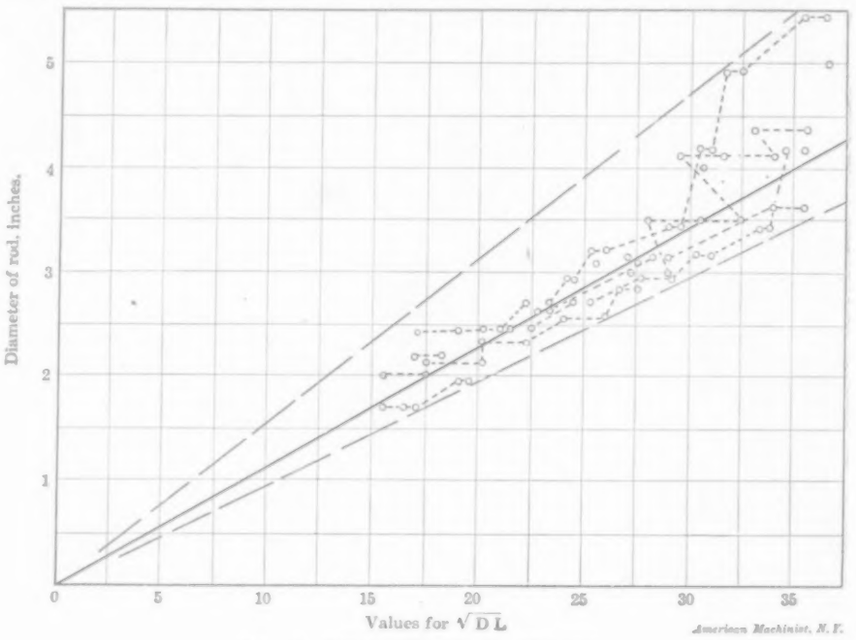


FIG. 2. PISTON ROD CORLISS ENGINES

Mean value of $C = 0.53$,
Maximum value of $C = 0.72$,
Minimum value of $C = 0.37$.

For high-speed engines:

Mean value of $s = 39.5$
Maximum value of $s = 57$,
Minimum value of $s = 28$.

For Corliss engines:

Mean value of $s = 43$,
Maximum value of $s = 61$,
Minimum value of $s = 32$.

While these pressures may seem high, it will be noted that cut-off usually takes place before midstroke is reached. If cut-off takes place at ¼ stroke (which is considered as the commercial point of cut-off in this examination) the steam pressure when at midstroke will be about one-half of its former value at this point. The earlier point of cut-off will reduce the unit pressures to safe working conditions under actual operation.

Crosshead Pin

Ratio of diameter to length of bearing part of crosshead pin in high-speed engines,

$$l = C\,d.$$

Mean value of $C = 1.25$,
Maximum value of $C = 1.5$,
Minimum value of $C = 1$.

For Corliss engines,

$$l = C\,d.$$

Mean value of $C = 1.43$,
Maximum value of $C = 1.9$,
Minimum value of $C = 1$.

The crosshead pin may be designed either for strength or for a definite unit bearing pressure on the projected area. For strength the crosshead pin may be treated as a fixed beam, in which case we will have,

Resisting moment = bending moment,

or

$$\pi/32\ f\,d^3 = \tfrac{1}{8}\,P\,l.$$

For high-speed engines, mean value of $l = 1.25\ d$, then

$$\pi/32\ f\,d^3 = \tfrac{1}{8}\,P \times 5/4\ d,$$

or

$$C_1\,d^2 = P = p\,A = p\,\pi/4\,D^2,$$

and

$$d = C\,D.$$

In treating the crosshead pin for a definite unit bearing pressure on projected area, the following relation may be used:

$$d\,l = K\,A.$$

As before, take

$$l = 1.25\ d,$$

then

$$1.25\ d^2 = K\,A = K\ \pi/4\ D^2,$$

and

$$d = C\,D$$

as before.

This gives the same final expression for both cases and the equation $d = C\,D$ is used in plotting. As should be expected,

no difference was found in the value of C for high-speed and Corliss engines.

Mean value of $C = 0.25$,
Maximum value of $C = 0.28$,
Minimum value of $C = 0.17$.

Using the mean value of $l = 1.25\,d$ for the high-speed engines and $l = 1.43\,d$ for the Corliss engines, the following are the values of K and f, respectively:

For high-speed engines:

Mean value of $K = 0.10$,
Maximum value of $K = 0.15$,
Minimum value of $K = 0.037$.
Mean value of $f = 2500$,
Maximum value of $f = 5400$,
Minimum value of $f = 2000$.

For Corliss engines:

Mean value of $K = 0.115$,
Maximum value of $K = 0.19$,
Minimum value of $K = 0.037$.
Mean value of $f = 2870$,
Maximum value of $f = 6450$,
Minimum value of $f = 2300$.

Connecting Rods

The method of treating the connecting rods is similar to the method employed for the piston rods. The Euler formula for long columns is used and the constants modified for end conditions. As regards buckling in the plane of its motion, the connecting rod may be treated as having both ends free, but guided in the direction of the plane of the motion, and the formula becomes

$$P = \pi^2 \frac{E\,I}{L^2_c}.$$

For lateral deflection the rod may be considered as having both ends fixed, and the formula becomes

$$P = 4\,\pi^2 \frac{E\,I}{L^2_c},$$

where P is the greatest safe load for stability; E is the modulus of elasticity; I is the moment of inertia of mid-section; and L_c is the length of strut (center to center of connecting rod).

From a comparison of the above equations it is seen that the resistance of a rod of circular cross section to lateral deflection is four times as great as its resistance to buckling in the plane of its motion and hence it need only be considered for the latter condition. A rod of rectangular cross section may buckle in either plane depending upon the ratio of the hight h to the breadth or thickness b at the center. For the engines examined the mean ratio of h to b at the center of the rods was found to be 2.28.

The relation of $h = C\,b$ was used in plotting,

Mean value of $C = 2.28$,
Maximum value of $C = 3$,
Minimum value of $C = 1.85$.

By comparing the above formula for the resistance of a rod of rectangular cross section, to buckling in either plane for a given load, the following relation holds true:

$$\frac{\pi^2 E}{L^2_c} I_b = \frac{4\,\pi^2 E}{L^2_c} I_h,$$

or

$$I_b = 4\,I_h,$$

where I_b is the moment of inertia of the mid-section of the rod about the b, or shorter axis through the center of section, and I_h is the moment of inertia about the h, or longer axis through the center of the section, or

$$\tfrac{1}{12}\,b\,h^3 = \tfrac{4}{12}\,b^3\,h$$

and $h = 2\,b$.

This shows that when $h = 2\,b$ at the center for a rod of rectangular cross section, it will have equal rigidity against buckling in either plane. For the engines examined the mean value of $h = 2.28\,b$, and hence these rods need be considered for lateral deflection only.

Connecting rods of high-speed engines (rectangular sections only).

These are treated for lateral deflection and

$$P = 4\,\pi^2 \frac{E\,I}{L^2_c}.$$

If the rigidity of the rod is considered as determined by the breadth b and hight $2\,b$, the error will be only on the side of safety, and then

$$I = \tfrac{1}{12}\,b^3\,h = \tfrac{1}{12}\,b^3 \times 2\,b = \frac{b^4}{6},$$

then

$$P = p\,\pi/4\,D^2 = 4\,\pi^2 \times \frac{30{,}000{,}000}{L^2_c} \times \frac{b^4}{6}$$

and

$$b = 0.026\,\sqrt{D\,L_c}$$

(for factor of safety of unity).

The expression

$$b = C\,\sqrt{D\,L_c}$$

was used in plotting.

Mean value of $C = 0.073$,
Maximum value of $C = 0.094$,
Minimum value of $C = 0.05$.

This gives a factor of safety of

$$\left(\frac{0.073}{0.026}\right)^4 = 60.$$

Connecting rods of low-speed engines (circular sections only) are treated for flexure in the plane of their motion and

$$P = \pi^2 \frac{E\,I}{L^2_c},$$

or

$$125 \times \pi/4\,D^2 = \pi^2 \times \frac{30{,}000{,}000}{L^2_c} \times \frac{\pi\,d^4}{64},$$

and

$$d = 0.051\,\sqrt{D\,L_c}$$

(for factor of safety of unity).

The expression

$$d = C\,\sqrt{D\,L_c}$$

was used in plotting.

Mean value of $C = 0.092$,
Maximum value of $C = 0.104$,
Minimum value of $C = 0.081$.

This gives a factor of safety of

$$\left(\frac{0.092}{0.051}\right)^4 = 11.$$

Crank Pin

The ratio of length to diameter of crank pin may be expressed by

$$l = C\,d.$$

For high-speed engines:

Mean value of $C = 0.87$,
Maximum value of $C = 1.25$,
Minimum value of $C = 0.66$.

For Corliss engines:

Mean value of $C = 1.14$,
Maximum value of $C = 1.30$,
Minimum value of $C = 1.0$.

In treating the crank pin for strength it was, in the case of center-crank engines, taken as a simple beam having a length equal to the distance between the center lines of main journals of the engine, and for strength

resisting moment = bending moment,

or

$$\pi/32\,f\,d^3 \frac{P\,L_b}{4},$$

where d is the diameter of the pin and L_b is the distance from center to center of main bearings. The relation between the diameter d and the length L_b may be expressed by

$$L_b = C\,d.$$

The mean value of $C = 4.2$, then

$$\pi/32\,f\,d^3 = \frac{4.2\,P\,d}{4} = 1.05\,d \times p\,\pi/4\,D^2$$

$$C_1 d^2 = 1.05 \times 125 \times 0.78\,D^2$$

and

$$d = C\,D$$

which is the expression used in plotting.

For high-speed, center-crank engines,
Mean value of $C = 0.40$,
Maximum value of $C = 0.526$,
Minimum value of $C = 0.28$;
Mean value of $f = 6600$,
Maximum value of $f = 13{,}400$,
Minimum value of $f = 3800$.

The crank pin for side-crank Corliss engines was treated as a single cantilever beam having a length equal to the bearing

length of the crank pin, and in the same manner as before

$$\pi/32\, f d^3 = \frac{P l}{2},$$

where d is the diameter and l is the length of the crank pin.

The mean relation between the length and the diameter of the crank pin as already found is

$$l = 1.14\, d$$

and as before, the following final expression is obtained:

$$d = C D.$$

For side-crank Corliss engines:
Mean value of $C = 0.27$,
Maximum value of $C = 0.32$,
Minimum value of $C = 0.21$;
Mean value of $f = 7800$,
Maximum value of $f = 13{,}000$,
Minimum value of $f = 5500$.

Main Journals of Crank Shaft

Crank shafts are subject to variable combined bending and twisting moments, but these moments, when their magnitude and direction are known, can be reduced to an equivalent twisting moment by the formula

$$M_t = M + \sqrt{M^2 + T^2},$$

where M_t is the equivalent twisting moment, M the simple bending moment, and T the simple twisting moment for the point. If now the ratios of bending and twisting moments and of maximum to mean moments are constant, the above transformation will retain the same general form and change only in the numerical coefficient. In the engines examined there is a general agreement as to the above ratios of moments among engines of the same class.

For maximum fiber stress the main journals of the crank shaft may be treated as subjected to this equivalent twisting moment. A common expression for twisting moment is,

$$d = C \sqrt[3]{\frac{H.P.}{N}}$$

where d is the diameter of main journal; $H.P.$ is the horsepower of the engine, and N is the number of revolutions per minute.

For high-speed center-crank engines:
Mean value of $C = 6.6$,
Maximum value of $C = 8.2$,
Minimum value of $C = 5.4$.

For Corliss engines this relation seems best expressed by the form,

$$d = C \left(\sqrt[3]{\frac{H.P.}{N}} - B \right);$$

$B = 0.3$

Mean value of $C = 7.2$,
Maximum value of $C = 8$,
Minimum value of $C = 6.4$.

The relation between the length and diameter of the main journals of crank shafts may be expressed by

$$l = K d.$$

For high-speed, center-crank engines:
Mean value of $K = 2.1$,
Maximum value of $K = 2.9$,
Minimum value of $K = 1.6$.

For Corliss, side-crank engines:
Mean value of $K = 1.9$,
Maximum value of $K = 2.2$,
Minimum value of $K = 1.62$.

The relation between the projected area of the main journals and the area of the piston may be expressed by

$$d l = a = F A.$$

For high-speed, center-crank engines:
Mean value of $F = 0.48$,
Maximum value of $F = 0.78$,
Minimum value of $F = 0.32$.

For Corliss, side-crank engines:
Mean value of $F = 0.6$,
Maximum value of $F = 0.66$,
Minimum value of $F = 0.5$.

The Flywheel

The weight of flywheel rim was found to be almost too uncertain a value to lend itself to any satisfactory comparative treatment. There is a marked difference in opinion among the different engine builders, not only as to what would constitute a proper total weight of flywheel for an engine of certain horsepower, but there is an equally marked difference in opinion as to how much of the total weight should be considered as acting at the center of the flywheel rim in producing inertia effect.

Some manufacturers consider the total weight of the wheel as acting at the rim in producing inertia effect; others consider the weight of the rim, spokes and hub as all acting at their respective centers of gravity, the weight of the spokes being considered as about one-third of the total weight of the wheel; still others consider the weight of the rim and one-third of the weight of the spokes acting at their respective centers of gravity; and finally some consider the weight of the flywheel rim only and disregard the weight of the remaining parts of the wheel.

From the engines examined it was found that the weight of the rim of the wheel varied from 44 to 75 per cent. of the total weight of wheel in high-speed engines, and from 52 to 68 per cent. in Corliss engines.

In view of these variations it was deemed best to use the total weight of the wheel in plotting. And the formula that is most commonly used for finding the weight of flywheel was used.

It has the form

$$W = C \times \frac{H.P.}{D_1^3 N^3},$$

where W = the total weight of wheel; D_1 = the diameter of wheel in inches; and N = the number of revolutions per minute.

This relation gives fairly satisfactory results for high-speed engines up to about 175 horsepower, and for this range:
Mean value of $C = 1{,}300{,}000{,}000{,}000$,
Maximum value of $C = 2{,}800{,}000{,}000{,}000$,
Minimum value of $C = 660{,}000{,}000{,}000$.

But when high-speed engines of larger size are considered, the relation seems better expressed by

$$W = C \times \frac{H.P.}{D_1^3 N^3} + B;$$

$B = 1000$,

Mean value of $C = 720{,}000{,}000{,}000$,
Maximum value of $C = 1{,}140{,}000{,}000{,}000$,
Minimum value of $C = 330{,}000{,}000{,}000$.

A somewhat greater uniformity seems to exist among the builders of standard Corliss engines. In these engines the relation seems best expressed by

$$W = C \left(\frac{H.P.}{D_1^3 N^3} - B \right),$$

or

$$W = C \frac{H.P.}{D_1^3 N^3} - K;$$

$B = 0.000{,}000{,}004{,}5$

Mean value of $C = 890{,}000{,}000{,}000$
Maximum value of $C = 1{,}330{,}000{,}000{,}000$,
Minimum value of $C = 625{,}000{,}000{,}000$.

The corresponding values of K are:
Mean value of $K = 4000$,
Maximum value of $K = 6000$,
Minimum value of $K = 2800$.

The relation between the length of the stroke and the diameter of flywheel in high-speed engines may be expressed by

$$D_1 = C L,$$

where D_1 = the outside diameter of wheel in inches; and L = the length of stroke in inches:

Mean value of $C = 4.4$,
Maximum value of $C = 5$,
Minimum value of $C = 3.4$.

For Corliss engines,
Mean value of $C = 4.4$,
Maximum value of $C = 5.25$,
Minimum value of $C = 3.25$.

The relation between the width of the

face and the outside diameter of the flywheel may be expressed by

$$w = C\,(D_1 - B)$$

or

$$w = C\,D_1 - K,$$

where w = the width of face of flywheel; and D_1 the diameter in inches.

For high-speed engines:

$$B = 18,$$

Mean value of $C = 0.31$,
Maximum value of $C = 0.46$,
Minimum value of $C = 0.24$.

The corresponding values of K are:

Mean value of $K = 5.6$,
Maximum value of $K = 8.3$,
Minimum value of $K = 4.3$.

For Corliss engines:

$$w = C\,(D_1 - B),$$

or,

$$w = C\,D_1 - \mathrm{K};$$

$$B = 50.$$

Mean value of $C = 0.22$,
Maximum value of $C = 0.30$,
Minimum value of $C = 0.18$.

The corresponding values of K are:

Mean value of $K = 13$,
Maximum value of $K = 15$,
Minimum value of $K = 9$.

Belt Surface per Indicated Horsepower

The relation between the number of square feet of belt surface per minute and the horsepower of an engine may be expressed by

$$S = C \times \textit{horsepower},$$

where S = the velocity of flywheel rim in feet per minute multiplied by the width of belt in feet.

For high-speed engines:

Mean value of $C = 26.5$,
Maximum value of $C = 55$,
Minimum value of $C = 10$.

For Corliss engines, this relation seems better expressed by

$$S = C \times \textit{horsepower} + B;$$

$$B = 1000,$$

Mean value of $C = 21$,
Maximum value of $C = 35$,
Minimum value of $C = 18.2$

Velocity of Wheel Rim

Velocity of flywheel rim in feet per second; for high-speed engines:

Mean velocity = 70 feet per second,
Maximum velocity = 82 feet per second,
Minimum velocity = 48 feet per second.

For Corliss engines:

Mean velocity = 68 feet per second,
Maximum velocity = 82 feet per second,
Minimum velocity = 40 feet per second.

Weight of Reciprocating Parts

In this investigation the weight of the reciprocating parts was assumed to be directly proportional to the pressure on the piston and inversely proportional to the length of the stroke and to the square of the number of revolutions. Putting this in the form of a formula and remembering that the total pressure on the piston varies as D^2, the above relation gives the expression

$$W = C \times \frac{D^2}{L N^2},$$

where W = the weight of the reciprocating parts, composed of the weight of the piston, piston rod, crosshead, and one-half the weight of the connecting rod; D = diameter of piston; L = the length of stroke in inches; and N = the number of revolutions per minute.

Data for plotting were obtained for high-speed engines only.

Mean value of $C = 2{,}000{,}000$,
Maximum value of $C = 3{,}400{,}000$,
Minimum value of $C = 1{,}370{,}000$.

For the cases where the information was obtainable, the balance weight opposite the crank pin was found to be about 75 per cent. of the weight of the reciprocating parts.

Weight of Engine per Indicated Horsepower

The relation between the total weight of the engine and the number of horsepower may be expressed by

$$W = C \times \textit{horsepower},$$

where W = the total weight of the engine.

For belt-connected, high-speed engines:

Mean value of $C = 82$,
Maximum value of $C = 120$,
Minimum value of $C = 52$.

For direct-connected engines, the weight of the engine without the generator was found to be from 10 to 25 per cent. greater than the weight of belt-connected engines of the same capacity.

For Corliss engines:

$$W = C \times \textit{horsepower}$$

Mean value of $C = 132$,
Maximum value of $C = 164$,
Minimum value of $C = 102$.

Relation Between Area of Bed and Indicated Horsepower

The relation between the number of square feet of area occupied by the bed of the engine and the horsepower may be expressed by

$$A = C \times \textit{horsepower} + B.$$

For high-speed engines:

$$B = 10,$$

Mean value of $C = 0.32$,
Maximum value of $C = 0.44$,
Minimum value of $C = 0.2$.

This area may be increased by from 15 to 25 per cent. for direct-connected engines.

For Corliss engines:

$$B = 80,$$

Mean value of $C = 0.6$.

Conclusion

A comparison of the results obtained from this investigation and those obtained from a similar investigation carried out at Cornell University 10 years ago* reveals several interesting features. It shows that there has been a gradual change during the last decade, in the coefficients and factors of safety used in the design of the steam engine. It also shows how these coefficients and constants have been modified to meet existing conditions, and although there is still a great variation as to the practice among the different builders, in proportioning the different parts, there appears, however, on the whole to be a somewhat greater uniformity in this respect now than formerly.

The steam pressure used and assumed constant in this examination is 125 pounds per square inch as against 100 pounds in the former discussion. Notwithstanding this, the constants obtained in the two different discussions show in many instances a remarkably close similarity. The changes that have taken place seem to have been in direct accordance with the increase in pressure and speed.

In such parts as the piston rod, which can be based on rational treatment and designed for strength and rigidity, the results agree very closely. The results also agree very closely in the case of the connecting rods of the low-speed engines. In the case of the connecting rods of the high-speed engines there is an increase in the mean value of the factor C in the expression

$$b = C\sqrt{D\,L}$$

from 0.057, as found by Professor Barr, to 0.073, as found in the present discussion. This, since the factor of safety varies as the fourth power of the factor C, more than doubles the factor of safety. It increases from 27 to 60. While a factor of safety of 60 seems unnecessarily large and uncalled for, it may partly be accounted for by the increased steam pressure and speed used in recent years.

The relation between the thickness of the cylinder walls and diameter of cylinder is practically the same now as formerly.

*Trans., A. S. M. E., 18: 737.

The area of the crosshead shoes presents some differences. The present investigation shows the relation between the area of the crosshead shoes and the area of the piston to be the same for both high-speed and Corliss engines and gives a value which is about half way between what was found to be current practice for high-speed and low-speed engines 10 years ago. The present value of C in the relation $a = CA$ gives $C = 0.53$ for both high-speed and low-speed engines as against $C = 0.63$ for high-speed and $C = 0.46$ for low-speed engines in the previous examination. This gives an increase of about 45 per cent. in the unit bearing pressure on crosshead shoes in the case of high-speed engines and an increase of about 8 per cent. in Corliss engines over what was formerly found to exist. Improved methods of lubrication probably account for this in part.

In treating the crank pin and crosshead pin in the present discussion it was deemed more satisfactory to consider them on the basis of strength rather than on the basis of bearing pressures and friction alone as was done in the former discussion. The ratio of length to diameter of the crosshead pin is found to be practically the same now as formerly. Owing to the difference in the method of treatment of the crosshead pin, the result obtained in the two cases cannot be compared directly, but by substituting the mean values as found in this present investigation, the mean value for an expression similar to the one used by Professor Barr can be obtained. Knowing that

$$l = 1.25\ d,$$

and that

$$d = 0.25\ D,$$

these values can be substituted in the expression

$$a = l\,d = C\,A,$$

as used by Professor Barr and the corresponding value of C found. From the above expression

$$C = \frac{l\,d}{A} = \frac{1.25\ d \times d}{\pi/4\ D^2}$$

$$\frac{1.25 \times 0.25\ D \times 0.25\ D}{0.78\ D^2} = 0.10.$$

The mean value of C as found by Professor Barr was 0.08. This shows a slight increase in the ratio between the projected area of the crosshead pin and the area of the piston.

In order to obtain a comparison for the crank pin, values for high-speed engines were plotted for the equation

$$l = C \times \frac{H.P.}{L} + B$$

as used by Professor Barr, where l = length of crank pin, and L = length of stroke. The results are:

$B = 1.6$ inch,
Mean value of $C = 0.28$,
Maximum value of $C = 0.35$,
Minimum value of $C = 0.14$.

The corresponding values obtained by Professor Barr are:

$B = 2.5$ inches,
Mean value of $C = 0.30$,
Maximum value of $C = 0.46$,
Minimum value of $C = 0.13$.

These values show that for the same horsepower and length of stroke there is a considerable reduction in the length of the crank pin. This figure also shows that there exists, among the different engine builders, a much greater uniformity in proportioning the crank pin now than formerly. In treating the crank pin for strength, however, as was done in the present investigation, there is even a greater uniformity exhibited.

The ratio of length to diameter of main journals is almost identical in the two cases. And so also is the ratio of projected area of journals to the area of the piston. In the expression

$$d = C \sqrt[3]{\frac{H.P.}{N}}$$

there is in the case of the high-speed engines a decrease in the coefficient C from 7.3 to 6.6 which gives a corresponding decrease in the diameter. In the case of the Corliss engines a comparison of the diagrams shows that there has not been much change in the value of the diameter of main journals although the above relation seems to be better expressed in a slightly different manner at the present time.

In the case of the weight of flywheel, if Professor Barr in his examination used the weight of rim of flywheel only, then there is no comparison between the results obtained then and now. But if the total weight of wheel* was used in plotting, in the former case, then for engines up to about 175 horsepower there is a fairly close similarity in the two cases, the present tendency showing an increase in the weight of flywheels, a condition resulting no doubt from the exacting requirements of speed regulation of recent years.

The velocity of the flywheel rim is practically the same now as formerly. In the case of the number of square feet of belt surface per horsepower, there is a great reduction in the factor C in the relation $S = C \times$ horsepower. In the case of the high-speed engines, C has a value of 26.5 now as against 55 in the former discussion. This, seeing that the velocity of the flywheel rim is the same now as formerly, must mean a decrease in width and a corresponding increase in thickness of belts used for the same amount of power transmitted, at the present time.

In the expression

$$w = C \frac{D^3}{N\,L^3}$$

for the weight of the reciprocating parts, C shows an increase from a value of 1,860,000 10 years ago to a value of 2,000,000 at the present time.

The weight of the engine per horsepower shows a decrease of 29 per cent. in the case of the high-speed engines and a decrease of 25 per cent. in the Corliss engines below what it formerly was. The constants in the relation $w = C \times$ horsepower are 82 and 132 now as against 115 and 175 in the former discussion for the high-speed and Corliss engines, respectively. In fact, lightness of construction, good workmanship and materials of the greatest strength and durability are among the factors which have brought about the improvement of the steam engine and made possible the fulfilment of the present-day requirements.

[*This question we referred to Professor Barr, and following is his reply.—Ed.] "In regard to whether I consider the weight of the entire flywheel, or the rim only, in my investigations of engine proportions, I would state that the constants which I derived from practice relate to rim only. See *Transactions*, A. S. M. E., Volume XVIII, page 761.

Annealing High-speed Steel

By O. M. Becker

It is now customary for makers to furnish high-speed steel stock annealed, instead of as it comes from the hammers or rolls as formerly, though in most cases the unannealed can be had if especially ordered. In this way the bar stock becomes available in many ways without preparatory treatment. For example, it is a comparatively easy matter to machine tools direct from the stock as well as to forge them. The use of annealed steel lessens the unusual care required to bring tools out of the hardening treatment with the shanks or necks soft enough to minimize the danger of breakage at those points. It is to be noted also that the long annealing at the mills gives to the steel a uniformity and freedom from strains that would otherwise be difficult to produce, and thus limit the utility of tools made from it. Most high-speed steels can be made nearly or quite as soft as ordinary tool steels by proper annealing.

It often becomes desirable or necessary to anneal pieces in the tool-making plant. This may be because only the unannealed stock is at hand, or because the forging or other processes through which tools pass, before the final hardening, may have made them more or less hard, very likely unevenly.

Need of Furnace and Uniformity

If much annealing is to be done a suitable annealing furnace is requisite. A gas-fired oven is most often used, though the slightly less convenient coke- or anthracite-fired furnace is also suitable and satisfactory. An important requirement

in design is the ability to sustain a continuous high heat for a long period of time if necessary. For annealing in an ordinary tool-making plant, even this is not essential, for the heats need not be of the same duration as that given at the mills. A prime essential in annealing is uniformity, as a given piece must be annealed to the same extent throughout. Therefore the heating must be uniform, and it is necessary that the furnace be such that the heat will be evenly distributed throughout the fire or heating chamber. The coke furnace is especially good in this respect, though gas furnaces are now designed with muffle or baffle plates, or double floors, so as to accomplish this same result.

Quick and Slow Annealing

Quick annealing is not to be encouraged, for though fairly good results may sometimes be thus obtained, it must be remembered that proper annealing is a process requiring much care and good judgment. The slower the temperature is raised and then lowered the better the annealing. The heating should occupy anywhere from 2 hours to 10, according to the size and condition of the piece, and the extent to which the annealing is to be carried. The heat must thoroughly and uniformly penetrate the entire piece. If necessary to anneal a piece without any of the desirable appliances, this may be done, with more or less success, by heating slowly, in an open fire or furnace, to a blood red, holding there for some little time, and then allowing the heat to die down very gradually, the tool remaining in the fire or furnace until entirely cold. If a smith's fire be used, care must be taken to make it deep and to cover it up well after the desired heat is reached, so it will die down very slowly. It is better to build a hood of firebricks over the fire, and to fill this up with coke before the fire is allowed to go down. If a gas or coke furnace is used, air must be carefully excluded during the cooling so that excessive oxidation may be prevented.

Appliances for Slow Cooling

Instead of cooling down in the fire or furnace the piece may be withdrawn and buried in a goodly quantity of sand, ash, or lime, that has been previously well heated up and allowed to cool there. A quicker method is sometimes employed, which, however, is not very certain and but partially accomplishes the object. The steel is heated to a dull black red and plunged into hot water. The temperature of the piece must not exceed that indicated, while that of the water must be little short of the boiling point.

If possible the steel should be inclosed in a muffle, even if nothing better be at hand than a piece of gas pipe, and packed closely in green coal dust, coke dust, powdered charcoal, or like substance that will generate a non-oxidizing gas, and will envelop the pieces under treatment. It is much better to have a suitably designed muffle lined with firebrick; preferably a cast-iron one.

A rectangular box provided with a flanged lid is excellent for the purpose. The flange should fit very loosely into a grooved rim that projects from the top of the box. The groove can then be filled with sand or fireclay to exclude air. Clay effects this purpose rather better than sand. It is well to have one or more small holes through the cover for the escape of gases, as otherwise the clay filling might be blown off in places. It is very necessary to take all precautions for the exclusion of hot or cold air because surface oxidation of the steel takes place frequently to such an extent as to impair the uniformity of the subsequent hardening.

Annealing Temperatures

The box and contents should be placed in a moderately heated furnace and slowly brought to something more than a dark red; anywhere above the point at which softening is completed and below which recalescence begins, or between 1300 and 1450 degrees Fahrenheit. This temperature should be maintained for from one to four hours, according to the size of the box and of the pieces being treated. The point is to be sure that every piece is completely and uniformly heated throughout. Soaking, that is to say, long-continued heating, is likely to be injurious, and should be avoided as it tends to make the structure of the steel coarse and increase the liability to crack during the subsequent hardening.

It is, of course, possible to arrive, by experimentation, at a definite time that given bars or pieces should be heated in order to anneal perfectly, and without damage to the structure; but in miscellaneous work the conditions vary so much that no specific rule can be laid down. Only experience can be relied upon as a guide, though, of course, the limits above mentioned will indicate the approximate range of time within which the heating should be done.

Overheating and Underheating

It is better to underheat rather than overheat, or to continue the treatment for a shorter rather than for a longer time than seems probably necessary as the annealing can be repeated in case it has not been carried far enough.

More important still is the maximum temperature maintained. If raised considerably above that already indicated, i.e., 1450 degrees Fahrenheit, the purpose of the treatment is in part defeated, because near this temperature the changes begin to take place which are necessary for hardening, and the steel comes out imperfectly annealed, if indeed not quite hard at times; especially if the cooling takes place less slowly than it should. The temperature must on no account exceed 1650 degrees Fahrenheit, and frequent readings of the pyrometer are, therefore, very desirable.

The heating having proceeded until the steel has been completely and evenly heated throughout, the heat should be turned off and the furnace allowed to cool down very gradually, the slower the better, and the contents not removed until quite cool. This requires, under the best conditions, several hours. Twelve hours is short enough a time, and two or three times as long is better. Cold air must, during this time as well as during the rest of the treatment, be carefully excluded from the furnace.

Colors Left by Annealing

The surface of high-speed steel so annealed comes out very well, but usually somewhat discolored. It is sometimes desirable to leave the brightness of the surface unimpaired. This is accomplished to a moderate extent by placing in the bottom of the annealing box a handful of rosin and sifting a second handful over the top of its contents. A thin black film then covers the pieces when taken out.

This objection can be avoided by keeping the contents of the annealing box constantly surrounded by an envelop of gas, thus excluding air during the whole time. To do this there must be a continuous supply of gas passing into the box, which latter should be provided with a small iron pipe screwed into a suitable threaded hole at one end of the box and long enough to extend well outside the furnace. At the end of the annealing box opposite the pipe there should be a small orifice. The box having been filled and closed in the regular way, this pipe should be connected with a gas supply. The jet issuing from the small orifice, after all air has been driven out and the box filled with gas, is lighted and the box placed in the furnace to be heated in the customary manner. Before the heating begins the gas takes the place of air in the interstices around the steel and completely fills them during the entire treatment, so that there is no possibility of even enough oxidation to color the surface of the pieces. Very little of this gas is consumed. This method is excellent where it is necessary to anneal finished tools.

Electrical Annealing

Experiments have been carried on looking to electrical annealing and to bright annealing by immersion in a bath of fusible metallic salts, somewhat after the manner of the barium-chloride process for hardening. Moderately successful results have in some cases been obtained; but the methods are not as yet sufficiently developed for commercial use. The two methods have also been combined, with results apparently good, the salts bath being heated by the passage through it of a low-tension electric current.

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

A Problem in Stresses

The following problem has been a frequent visitor, and as there has been some discussion as to the proper method of

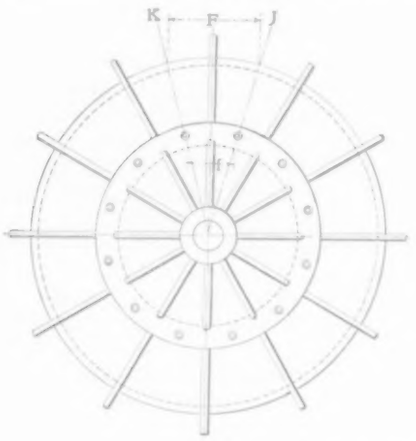


FIG. 2 *American Machinist, N.Y.*

DIAGRAM ILLUSTRATING A PROBLEM IN STRESSES

handling it, I am sending it to the "Upper House" for such criticism or suggestion as may seem to the members fit and proper.

Fig. 1 is a cross-section of a casing *A* circular in form, stiffened by the ribs *D*, with the heads *B* bolted on, and subjected to internal pressure, tending to rupture it along the line *C*.

One method of attack is to assume a cantilever T-shaped beam of a length *E* and breadth *F f* fixed at the end *G*, uniformly loaded over its entire length, and carrying in addition a concentrated load at the end *H* equal to the total pressure on a segment of the head bounded by the lines *J K*, Fig. 2, produced to the center.

The heads *B* are assumed to be stiffened by the radial ribs, so as to have no deflection that would produce an abnormal stress in the casing *A*.

The circular form, as shown in Fig. 2, undoubtedly adds something to the strength of the beam, and the opinion has been advanced that this addition would be equivalent to a reduction of the load equal to 20 per cent. This does not take into consideration the diameter of the casing, and for that reason does not find favor all around, as it is argued that the arch action, if there is any, would be more pronounced with a small diameter of head than in a large one, and the coefficient should be varied by some function of the diameter.

So far as I am aware, there have been no failures by rupture or undue deflection, but the criticism has been made that there was an excess of material which, from the point of cost, is objectionable.

Fig. 3 will probably indicate in a plainer

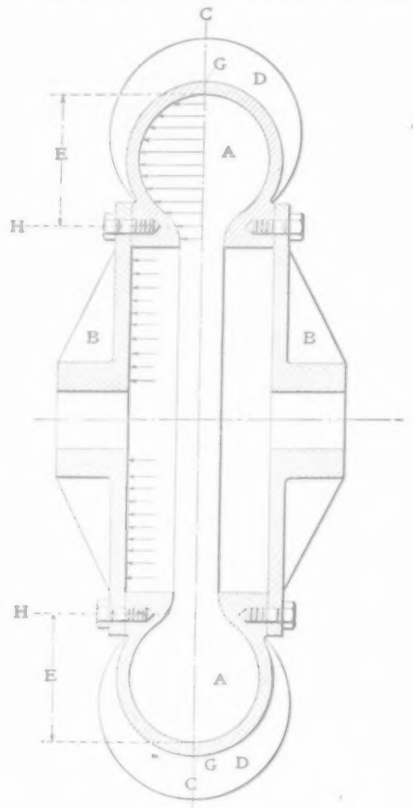


FIG. 1

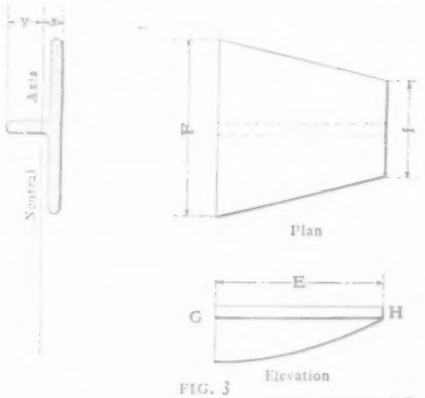


FIG. 3 *American Machinist, N.Y.*

DIAGRAMS ILLUSTRATING A PROBLEM IN STRESSES

way just how we go about it, the reference letters being the same as in the other figures. Assume a uniformly distributed load over the entire surface of the beam as in the plan view; this load we will call *W*. The bending moment $= M$, will be $\frac{WE}{2}$. Assume a load concentrated at the end *H* of the beam, which we will call W_1, and the bending moment due to this load $= M_1$, will be $W_1 E$, and the total bending moment $= M_2$, will be $M + M_1$. The moment of inertia $= I$. The section modulus $= S = \frac{I}{y}$, y being the distance from the neutral axis to the most remote fiber; and the fiber stress will $= \frac{M^2}{S}$. This fiber stress so found is to be reduced by 20 per cent. to get the actual stress. How about it?

Philadelphia, Penn. I. G. NORMAN.

Two Friction Clutches

Of the making of friction clutches there is no end. Yet two that I have used with more or less success may be of interest. The first, Fig. 1, was used on a small turret lathe. The action is especially powerful. The clutch ring *A* expands inside the cone pulley, and *B* expands inside the face gear. The sliding spool *C*, acting through the two toggle arms *D D*, presses apart the two levers *E E*, which, in turn, press against the set screws *F F* in the ears in the expanding ring. Adjustment for wear is made by means of the set screws *F F*, which can be easily reached through the opening between the face gear and the cone pulley. The first clutch of this kind was unsatisfactory because I did not leave the opening *G* in the expanding ring. This is necessary, otherwise only a small part of the circumference of the ring gets a bearing in the pulley.

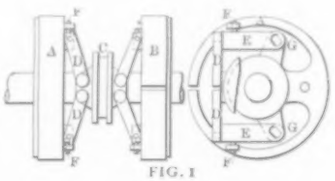


FIG. 1

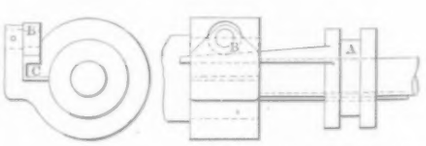


FIG. 2 *American Machinist, N.Y.*

TWO FRICTION CLUTCHES

In all such clutches it is an advantage not to key the friction disk, or expanding

ring, directly to the shaft, but to drive it from a circular plate, keyed to the shaft, by means of a dog pin, which had best be rather loosely fitted. In this way the ring in expanding can adjust itself to the bore of the pulley and yet drive the shaft without binding on it.

The second clutch was for some rough work where we had been troubled by being called on to adjust other styles of clutches too often. The men using them were unwilling to exercise the necessary patience to attend to them. In this case the driving was through the spool *A*, being held from turning on the shaft by a feather. (Two feathers are better than one if put opposite each other.) The projecting wedge on *A* was between the roll *B* on the friction band and the projecting lip *C* on the other side.

The beauty of this clutch is that all the adjustment necessary, or possible, consists in forcing the wedge farther in. It requires a strong arm on the shipper lever and is apt to stick when you want to pull it out, but in a case of need it is not a half-bad clutch to know about. In one place I found that they had driven a pin into the hub of the pulley, so that when the wedge stuck through the friction band it would strike against it and make a positive drive. It worked, except occasionally when they slammed the lever over too quickly and broke off the pin.

Fitchburg, Mass. CON WISE.

Taper Turning Tool for the Turret Lathe

The sketches show a taper-turning box tool which I designed and made for finishing taper keys for cocks, valves, etc. Fig. 1 is an isometric view, which I believe shows very plainly how the tool is constructed and operated. The tool can be used either in hand or automatic screw machines and is adjustable to turn any desired taper for the work in hand. This adjustment for the taper plate *A* is obtained as shown in Fig. 2, by means of the adjusting screws *B B* at the underside of the tool. To adjust or set the taper plate it is only necessary to loosen the screw *C*, Fig. 2, when the screws *B B*, which bear against the taper plate can be turned. When the desired angle for the taper plate is obtained screw *C* is tightened to clamp the plate to the slide *D*, Fig. 2.

The first operation on these keys is made with a combination drill and facing tool, which drills the hole and faces the end of the key square. The second operation is to tap this hole with a tap carried in an automatic holder. The third operation is performed with a hollow mill. This turns the shoulder for a spring washer. For the next operation the taper-turning tool is used, a roughing cut being taken to within 1/32 inch of the finished size. On the completion of this cut the turret is turned and brings into position a taper-turning tool for the finishing cut, which turns the key to the correct size. A cutter held in the tool post on the cross slide forms the throat or neck shown at *E*, Fig. 1. This completes the turning of the key.

In the operation of the taper-turning tool, as the turret is advanced to the work, the piece *F*, Fig. 1, moves the dovetail slide *D*, and as the taper plate is attached to this slide it necessarily moves with it. The taper plate has a slot *G* cut in it and in this slot is fitted a sliding block *H*, which is made of phosphor bronze and is free to adjust itself to any angle at which the taper plate may be set. This block controls the movement of the cutter, which is of 5/16 inch square Mushet steel. The sliding block is of such length that in the full movement of the cutter it will have a bearing the total length of the slot *G*. This is important as it keeps its bearing in the seat straight the entire length.

After the tool has finished its cut the slide with its taper plate is extended beyond the body of the tool, as represented at *I*, this being caused by the bar *F* acting upon the slide during the advance of the turret and tool along the work. When the turret is rotated the cam roll *J*, which is fastened near the end of the slide, strikes the cam shown in Fig. 3, which is made of flat steel, hardened and ground and fastened on the top of the turret slide. Fig. 3 shows the position of the roll as it starts on the cam and also as it reaches the high point. This movement along the cam pushes the slide *D*, Fig. 1, to the front of the tool and in position again to start its cut on the work. The bar *F* starts the operation of slide *D* before the tool begins to cut. Block *K*, which holds the cutting tool, and the slide *D* have 45-degree bearing surfaces at the sides and both are provided with phosphor bronze taper gibs adjusted with fine-pitch screws. These tools can also turn straight work if necessary.

The keys machined in this way were formerly turned with the slide rest on speed lathes, and were handled five different times. With the use of the taper tools the cost of the keys has been greatly reduced. They will also work very satisfactorily for making pins from the bar by leaving the front of the tool as shown by the dotted lines *L*, Fig. 1, and inserting a hardened bushing having a hole the size of the bar. The keys are now handled but once. They are held in a spring chuck, which clamps the handle *M*. As the cutting tool is withdrawn from the work in a straight line it does not bear on the piece, and thus marking of the finished surface is avoided. The bar *F*, Fig. 1, in this case is attached to the side of the headstock with a hinged joint to allow it to be thrown out of the way when using the cross-slide tool post.

Edwardsville, Ill. J. H. BLAIR.

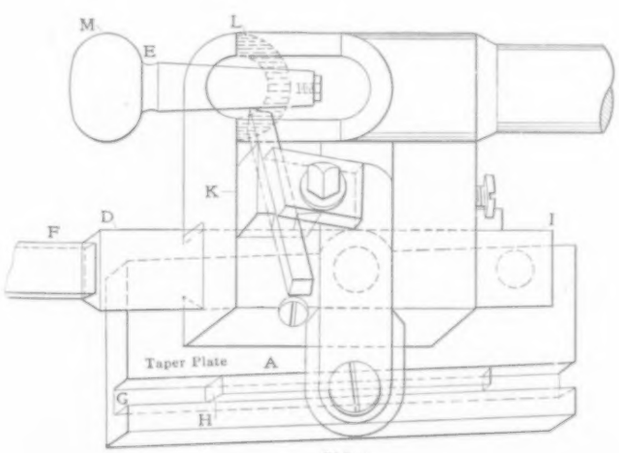


FIG. 1

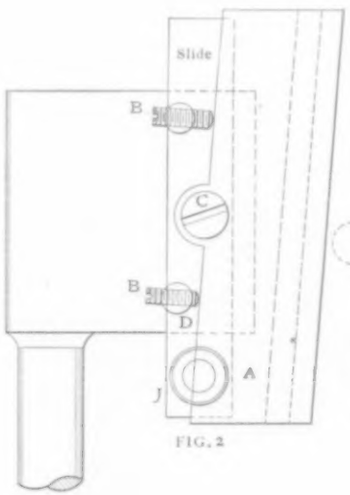


FIG. 2

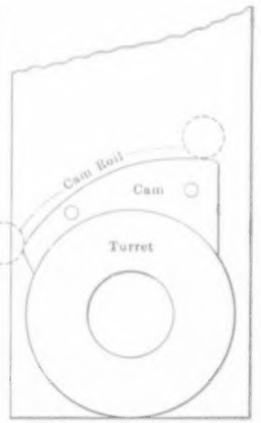


FIG. 3

American Machinist, N.Y.

TAPER TURNING TOOL FOR THE TURRET LATHE

Automatic Gear Cutting Attachment for the Milling Machine

The drawing shows an automatic gear-cutting fixture to be used on a milling machine. It can be connected to the regular feed by means of a universal joint, or may be driven by a countershaft, through the bevel gears *A*, worm gearing *B* and rack and pinion *C*. This fixture was designed to cut three 12-tooth bevel pinions at one time. These pinions were cut with special cutters which give a correct-shaped tooth with one cut.

When the work has traveled the proper distance for the cut, the adjustable collar *D* comes in contact with the slide. This moves the rod *E* which is connected to the lever *F*, and disconnects clutch *G*; the pinion *C* being free to revolve on the shaft, allows the weight which is fastened to the slide to return the work for another cut. On the return of the slide the cam *H* comes in contact with the inclined side of the trip *I*, which moves the plunger clear of the index dial. As the cam clears the trip at the same time the plunger clears the index, it allows the plunger to return in time to catch the next notch. The plunger is returned by means of a spring on top of the cam. The index dial is revolved by means of a weight which rotates the spindles through spiral gearing on the index shaft.

This fixture could be modified to cut either spur or bevel gears of quite a wide range. As the indexing and return are almost instantaneous, it makes a very rapid way of cutting gears.

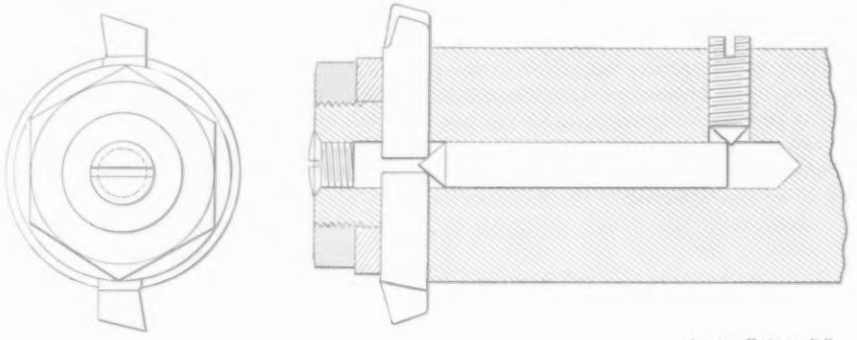
Hartford, Conn. P. F. SETAG.

A Boring Bar with Adjustable Cutters

The sketch shows a boring bar which is used in a large engineering works in Lancashire for boring machinery steel and 0.35 carbon steel. It will enlarge a 1⅝-inch hole to 2⅝ inches at 4 inches per minute, or 1⅝ to 3 inches at 3 inches per minute with ease.

With two pairs of cutters of different lengths it will bore any hole from 1⅝ to 4 inches. The setting of the cutters is accomplished by means of the small screw and rod. Although the idea is not new, it is not generally known, and may interest some fellow readers.

Wigan, England. W. H. LEAK.



American Machinist, N.Y.

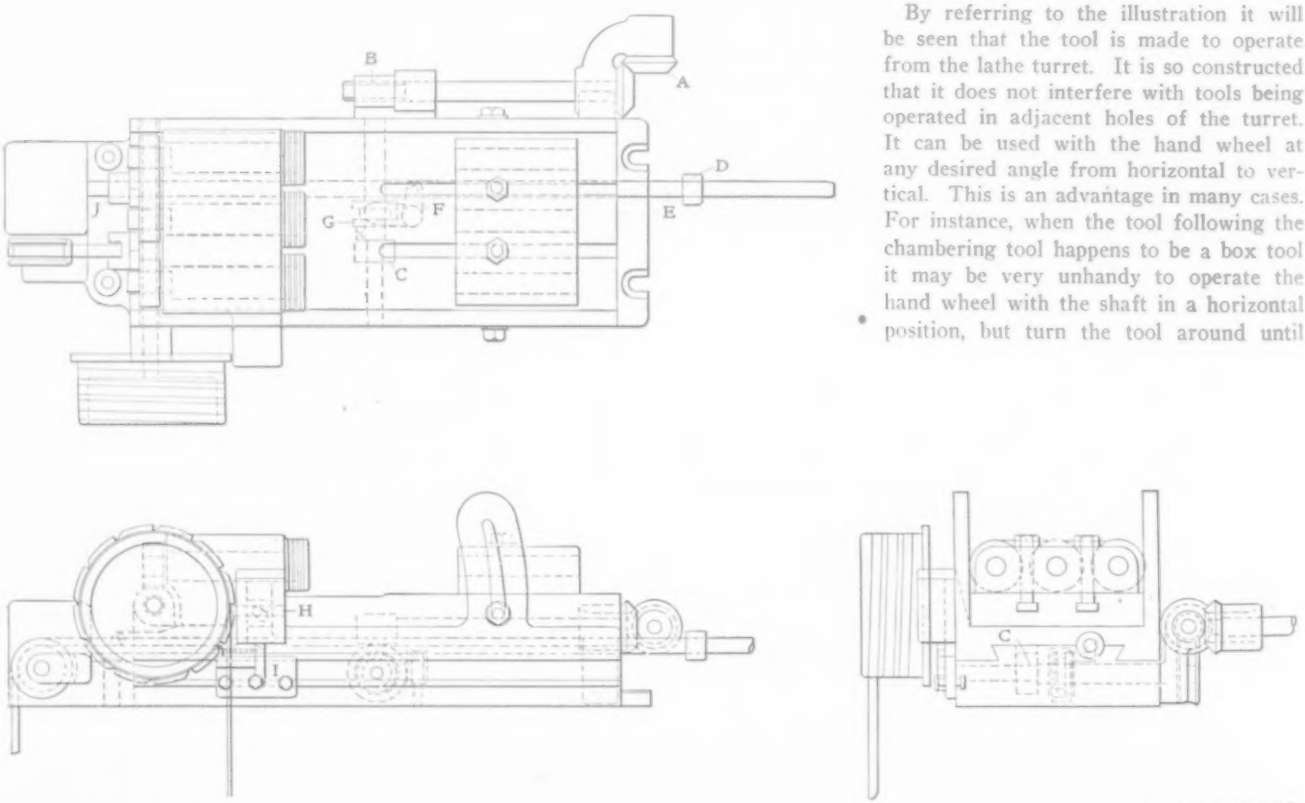
BORING BAR WITH ADJUSTABLE CUTTERS

A Chambering Tool for the Turret

At one time we had a great many sleeve-like parts to machine, and had prepared to do them on a turret lathe at one chucking. Finally after all preparations had been completed to machine them this way it was decided that they must be chambered.

As it was impossible to do this in any convenient and rapid manner on the turret lathe it looked as though a second chucking was unavoidable. But here a difficulty arose. With the limit allowed for machining the parts a second handling was out of the question. After some thought on the matter the tool which is the subject of this article was hit upon as being a solution of the difficulty. It was made and proved satisfactory from the start, thereby getting us out of our trouble, and adding almost nothing to the cost of machining.

By referring to the illustration it will be seen that the tool is made to operate from the lathe turret. It is so constructed that it does not interfere with tools being operated in adjacent holes of the turret. It can be used with the hand wheel at any desired angle from horizontal to vertical. This is an advantage in many cases. For instance, when the tool following the chambering tool happens to be a box tool it may be very unhandy to operate the hand wheel with the shaft in a horizontal position, but turn the tool around until



American Machinist, N.Y.

AUTOMATIC GEAR-CUTTING ATTACHMENT FOR MILLING MACHINE

the shaft stands at 45 degrees, or even vertical, and the hand wheel can be operated easily.

C represents the cutter heads, of which there are four, each holding an adjustable tool. When the tools are in a neutral position they do not extend beyond the line of the body of the tool proper, so that the tool can enter a hole no larger than its own diameter. A partial revolution of the cutter heads throws the cutting tools out beyond the body of the tool proper and in an aggressive position. The cutter heads are revolved by means of a pinion *P* cut on the back end of each, and meshing with an internal gear *G* cut on the worm wheel, which is in turn operated by the worm and hand wheel seen in the illustration.

A feature of the tool is the graduated dial *D*. This makes it possible for the operator to chamber to approximately the same diameter each time. The graduations, of course, have no positive reading, because a variation in the length of the cutting tools would change the readings. The operator simply sets the dial at zero when the cutting tools are out to the diameter of the bore. He notes then the reading when the tools are extended to the desired diameter of the chamber, and brings the dial around to this point each time.

The cutter heads are held in the tool body, and the wear of the heads is taken up by means of semi-circular pieces fitting in the grooves *W*. These pieces have bearings on the rear sides of the bevel surfaces only, and are adjusted up and down on the tapers by the V-pointed screws let in from the exterior of the tool body.

The four cutter heads disposed as they are on two right-angle diameters of the tool proper equalize the cutting strains, and make it possible to machine more rapidly than with fewer or differently arranged cutters.

Cincinnati, O. J. M.

Drilling Smooth Holes in Aluminum

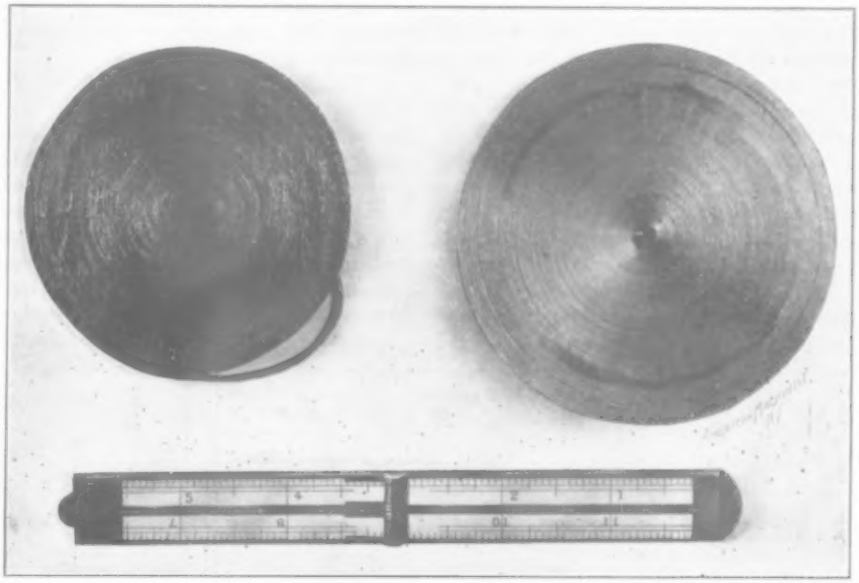
I write this thinking that the readers might be interested in an experiment which we tried some time ago, in the drilling of aluminum. To drill aluminum, and get a perfectly smooth bore, requires more or less care, as owing to the nature of the metal the reamer will clog and the consequences are that often the piece is only fit for the scrap heap when it is finished. As we had a number of pieces to drill, we decided to try a new method, so instead of using the usual reamer drill, which, in this case, was 1 3/64 inches, we used a 1-inch drill ground just a little out of center, with the lips backed off the same as for brass. This left almost 3/64 of an inch for the reamer. We then speeded the machine up and let the reamer, which was a new one, feed through on slow feed, using a generous supply of common machine oil. The result exceeded our expectations, for we secured a perfect bore not only in one or two, but in over 100 holes, and it proved to be a sure way to get a perfect hole no matter what its size.

CHAS. M. HAUGHEY.

Pearl River, N. Y.

An Interesting Chip

The halftone shows a rather unusual chip from one of our cutting-off machines.



AN INTERESTING CHIP

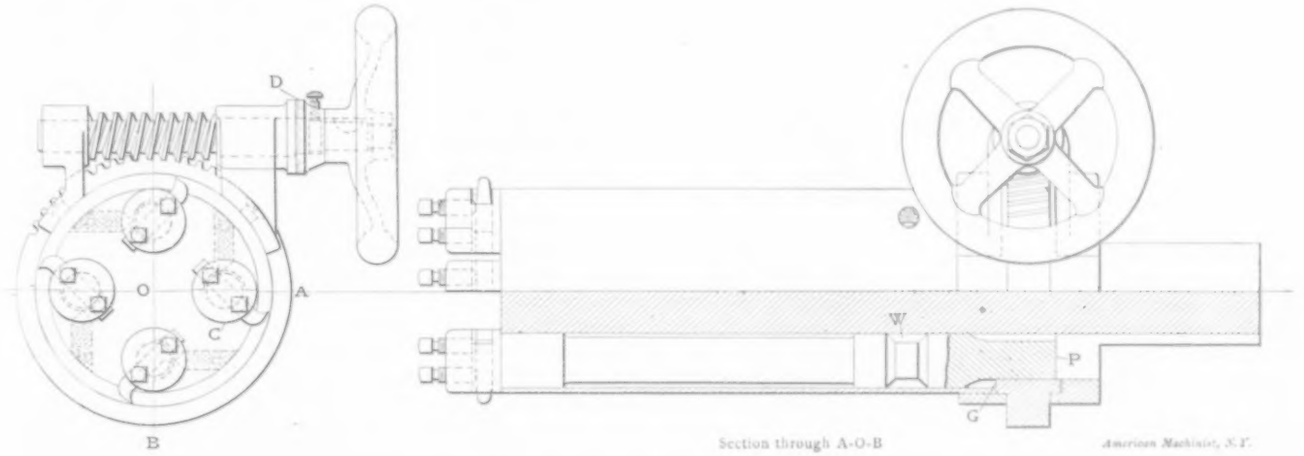
The chip is 3 inches in diameter, has more than 109 convolutions 0.013 inch thick and a total length of 75 feet.

The material is 0.25 carbon machinery steel, and the machine was running at a cutting speed of 70 feet per minute.

The cut gives a very good idea of the comparative size of the bar and chip, which was so closely wound as to appear solid.

W. W. BLAKEMAN.

The Bullard Machine Tool Company, Bridgeport, Conn.



A CHAMBERING TOOL FOR THE TURRET LATHE

The Proposed New French Customs Tariff Bill

An Analysis of the New French Customs Tariff Bill in so far as It Concerns the Interests of the Machinery Manufacturers

SPECIAL CORRESPONDENCE

After prolonged deliberations the committee on tariff revision of the French Chamber of Deputies recently submitted to the French parliament the draft of a new customs tariff. A large number of the sections of the old tariff are amended in the new bill, and classifications particularly have been greatly changed. Of course, the proposed customs tariff is merely in its preliminary form and considerable alteration as well as a tremendous amount of discussion and opposition may be looked for before the tariff will assume its definite form.

It is of great interest to American manufacturers of machinery to have these preliminary data at their disposal and for their convenience the tables immediately following have been prepared.

The duties on electric machinery, machine tools and the principal detached parts of machinery are given in the two last columns. Where the classification remains unchanged the present rates of duty are found in the first two columns. Where the classification has been changed, the new classification and rates are given separately, and the old rates follow in italics.

There are two different rates of duty in the French customs tariff; the general tariff rates and the minimum tariff rates. All American manufactures of metal enter France under the higher rates of the general tariff, for the French-American commercial agreement, which is soon to be abrogated as the result of our own tariff revision, did not apply to manufactures of metal.

Under the treaty of peace at the termination of the Franco-Prussian war, France obligated herself for all time to grant Germany the most favored nation treatment with regard to imports into France. France cannot grant to any nation a concession with regard to customs duties that would not immediately become operative in favor of Germany. Great Britain also enjoys the favored nation treatment. Therefore German and British machinery enters France under the minimum rates of duty, while American manufactures of metal are subject to the highest rates of duty.

As a matter of fact it was this intolerable provision in favor of Germany, the effect of which has been an indiscriminate dumping of German products into France, that loomed largely behind the agitation for French customs revision. The new tariff is characterized by increases of rates and certain reductions on articles not exported by Germany. Of course, many of the increases will not finally stand, for some, as is usual in such cases, were made as a basis for demanding concessions.

In the following tables sections 510 to 523 are omitted. These refer to steam engines, hydraulic engines (no changes in the latter) pumps and ventilators (reductions under the general tariff), textile machinery, paper-making machinery, agricultural machinery, not including motors, (increased under general tariff from 15 francs per 100 kilograms to from 16 to 30 francs per 100 kilograms according to weight of machine).

Under section 524, dynamo-electric machines, there are no changes, but under 524 C considerable reductions are granted under the general tariff on electric and electrotechnic apparatus, the classifications remaining unchanged.

No.		Present Tariff.		Proposed Rates of Duties.	
		General.	Minimum.	General.	Minimum.
		Francs per		100 kilograms.	
	Detached pieces of cast iron, wrought iron or steel other than parts of steam boilers:				
	Of wrought iron or of wrought or cast steel, bored, turned, filed or adjusted, weighing				
	300 kilograms and more	*20*	*12*		
	100 to 300 kilograms	*25*	*15*		
	Less than 100 but more than 1 kilogram	*40*	*25*		
	1 kilogram or less	*50*	*35*		
	[All of the above detached parts of machinery are at present dutiable as follows:]				
	Parts of turbines			75	50
	Balls for ball bearings of a diameter greater than 10 millimeters			53	25
	5 to 10 millimeters			150	100
	Less than 5 millimeters			300	200
537	Machinists' tools:				
	Hoisting apparatus:				
	Screw jacks and screw cranes			15	10
	Block and tackle, weighing each:				
	100 kilograms and more			33	22
	15 kilograms and less than 100 kilograms			45	30
	Less than 15 kilograms			52.50	35
	Other			15	10

No.		Present Tariff.		Proposed Rates of Duties.	
		General.	Minimum	General.	Minimum.
		Francs per		100 kilograms.	
	Vises of all kinds, casings for screw plates, wrenches, catches, drills, drill holders, machine keys and other keys with wooden handles, split keys, weighing each:				
	15 kilograms or more			22.5	15
	5 kilograms and less than 15 kilograms			45	30
	3 kilograms and less than 5 kilograms			70	45
	Less than 3 kilograms			90	60
	Bits, screw-shaped, American augers and others, tap borers, stamps and matrices, chisel blades, tools for threading, turning, planing, mortising, cutters, borers, blades for boring, cylinder borers, instruments of precision for measurement and verification (such as rings, buffers, calipers, gauges, caliper gauges, rules, compasses of precision, etc			15% ad valorem	10% ad valorem
	Other tools			33	22
	Tools with or without handles of pure iron	*18*	*12*		
	Of steel or of iron tipped with steel	*27*	*22*		
	Of copper	*35*	*30*		

Coming to machine tools under 525 we find important changes, both as to classification by weight and to increases in the rates of duty. The old series of heavy machine tools weighing from 1000 kilograms upward, is split under the new arrangement into those weighing from 1000 kilograms up to 5000 kilograms and upward. The increase is very considerable. This applies to all machine tools, excepting to small machine tools weighing from 100 to 250 kilograms.

It is important to note that under the new tariff groups of parts detached from machines, for which is claimed the right to be assessed under some other number

No.		Present Tariff. General.	Present Tariff. Minimum.	Proposed Rates of Duties. General.	Proposed Rates of Duties. Minimum.
		Francs per 100 kilograms.			
524	Dynamo-electric machines and turbo-alternators	No change			
524 C	Electric and electro-technical apparatus:				
	Containing coils of insulated wire and weighing:				
	1000 kilograms and more	50	30	50	30
	200 kilograms inclusive to 1000 kilograms exclusive	120	45	70	45
	50 kilograms inclusive to 200 kilograms exclusive	120	60	90	60
	10 kilograms inclusive to 50 kilograms exclusive	120	80	120	80
	5 kilograms inclusive to 10 kilograms exclusive	150	100	150	100
	Less than 5 kilograms	150	110	165	110
	Not containing coils of insulated wire and weighing:				
	1000 kilograms and more	45	20	30	20
	200 kilograms inclusive to 1000 kilograms exclusive	45	30	45	30
	50 kilograms inclusive to 200 kilograms exclusive	120	40	60	40
	10 kilograms inclusive to 50 kilograms exclusive	120	60	80	60
	Less than 10 kilograms	150	80	120	80
525	Machine tools:				
	Heavy, weighing over 5000 kilograms	15	10	38	23
	Over 1000 and up to 5000 kilograms inclusive	15	10	42	28
	Medium, weighing more than 250 and up to 1000 kilograms inclusive	20	16	54	36
	Small, and of precision, weighing 100 to 250 kilograms, inclusive	70	50	75	50
	Less than 100 kilograms	70	50	90	60
525 C	General machinery:				
	Milling machinery, machinery for bolting, cylinder mills, for the manufacture of alimentary pastes, balances, scales			15	10
	Fixed railway and tramway stock:				
	In common steel			15	10
	In special steel (containing more than 5 per cent. manganese ore, more than 0.25 per cent. chromium, nickel, etc.)			45	30
	Typewriters			75	50
	Calculating machines			60	40
	Machines for rinsing, corking and placing capsules on bottles			23	15
	Machines for filling bottles			38	25
	Complete apparatus not elsewhere mentioned			12	8
	General machinery: Transmission gearing, balances, scales, fixed railway stock, signals, presses, hoisting apparatus, apparatus not specially mentioned, driven mechanically	15	10		
526	Boilers:				
	Steam boilers of steel or iron plate, sectional or not, with or without feed water heaters or internal furnaces, without tubes	12	9	13.50	9
526 C	Steam boilers of steel or iron plate, tubular or semi-tubular	18	14	18	14
526 C	Steam boilers multi-tubular			27	18
527	Sugar machinery, heating apparatus for breweries, distilleries, perfumeries, pharmacies and kitchens, copper and bronze predominating, weighing 250 kilograms or more	30	20	30	20
	Less than 250 kilograms	50	40	60	40
527 C	Refrigerating machinery and apparatus, weighing 500 kilograms and more	30	12	24	12
	250 kilograms inclusive to 500 exclusive	30	14	28	14
	Less than 250 kilograms	50	25	50	25
532	Detached pieces of machines and of transmission gearing of non-malleable cast iron, turned, filed or adjusted, weighing over 1000 kilograms			18	12
	More than 200 and up to 1000 kilograms			22.50	15
	200 kilograms and less			30	20
	Cylinders for rolling metals, cylinders, jaws, etc., for crushers, mill rollers of tempered cast iron (case hardened) turned, filed or adjusted, mounted or not on shafts of iron or steel, weighing more than 1000 kilograms			21	14
	More than 200 up to 1000 kilograms			25.50	17
	200 kilograms or less			33	22
	Detached pieces of cast iron, wrought iron or steel other than parts of steam boilers: Of cast iron, turned, filed or adjusted, weighing 1000 kilograms or more	18	12		
	200 to 1000 kilograms	20	15		
	Less than 200 kilograms	25	20		
533	Detached pieces of machines, of brake apparatus, of transmission gearing, of wrought iron or of wrought or swaged steel, of iron, of cast steel, or of malleable cast iron:				
	Of malleable cast iron, of wrought iron or common steel, weighing:				
	More than 300 kilograms:				
	Rough			15	10
	Worked			22.50	15
	More than 100 up to 300 kilograms:				
	Rough			18	12
	Worked			25.50	17
	More than 15 up to 100 kilograms:				
	Rough			22.50	15
	Worked			37.50	27
	More than 1 up to 15 kilograms:				
	Rough			37.50	25
	Worked			48	32
	1 kilogram and less:				
	Rough			45	30
	Worked			57	
	Of special steel (containing over 5 per cent. manganese or similar valuable metal) weighing:				
	More than 300 kilograms:				
	Rough			22.50	15
	Worked			30	20
	More than 100 to 300 kilograms:				
	Rough			27	18
	Worked			34.50	23
	More than 15 and up to 100 kilograms:				
	Rough			33	22
	Worked			40.50	27
	More than 1 kilogram up to 15 kilograms:				
	Rough			52.50	35
	Worked			63	42
	1 kilogram and less:				
	Rough			67.50	45
	Worked			79.50	53
	Straight shafts, solid, weighing more than 1000 kilograms:				
	Rough			12	8
	Worked			19.50	13
	100 to 1000 kilograms:				
	Rough			13.50	9
	Worked			21	14
	10 to 100 kilograms:				
	Rough			15	10
	Worked			25.50	17
	Less than 10 kilograms:				
	Rough			22.50	15
	Worked			34.50	23
	Straight shafts, bored, and bent shafts, shafts with cranks, weighing over 1000 kilograms:				
	Rough			18	12
	Worked			27	18
	From 100 to 1000 kilograms:				
	Rough			22.50	15
	Worked			33	22
	From 10 to 100 kilograms:				
	Rough			30	20
	Worked			42	28
	Less than 10 kilograms:				
	Rough			45	30
	Worked			60	40

of the tariff than No. 525, must be accompanied by a drawing of the machine with an indication of the place for said parts.

Under section 525 C are important changes of classification and considerable increases.

There are under section 533 remarkable classification changes and increases of duty on detached parts of machinery.

Of particular interest are the new duties under section 537, affecting machinists' tools, which were not specially mentioned in the old tariff.

Charles Talbot Porter is Presented with the John Fritz Medal

The ceremony of the presentation of the John Fritz medal, following its fifth award, took place in the auditorium of the Engineering Societies building on Tuesday evening, April 13. The recipient was Charles Talbot Porter; the meritorious work for which it was awarded was the improvements in high-speed steam-engine practice. In response to the request of the Board of Award to give distinction to the event, and to make it memorable and fittingly conspicuous, a large and appreciative audience, including many ladies, filled the auditorium.

Henry R. Towne, chairman of the Board of Award The John Fritz Medal for 1909-1910, presided. Because of its peculiarly fitting application as an introduction to the work of Mr. Porter, the first address, "The Debt of Modern Industrial Civilization to the Steam Engine as a Source of Power," by W. F. M. Goss, was given before the presentation.

Civilization's Debt to the Steam Engine

Dean Goss stated that the dreams of the possibilities of steam belonged to the day of Addison, Steele, Swift and Defoe; days when there were brilliant men of letters, triumphs in architecture, achievements on the battlefield, but when there were no means of doing industrial work. There were no large factories in England because there was no way by which their machinery could be driven. Many mines were abandoned because they were flooded with water; in others women and girls toiled in suffering and degradation. The transportation of merchandise by land was laborious; traveling by sea was slow and dangerous.

Into the midst of such conditions came the steam engine. It freed the mines from water, revived dormant industries, introduced new systems of manufacture, supplied power, water and effective means of sanitation to cities; comforts and necessities supplemented in later years by electric lighting, power and transportation. Steam usurped the place of wind in the propulsion of ships, and ships and locomotives have carried civilization to the farthest ends of the earth. These achievements are direct contributions to the upbuilding of our modern civilization, the keynote of which is service.

Following this introductory address Jesse M. Smith, president of the American Society of Mechanical Engineers, introduced Mr. Porter to the assembly, briefly outlining his distinguished engineering achievements. The simple ritual of presentation was spoken by E. Gybbon Spilsbury, during which Mr. Porter received the medal and an engraved certificate of award; meanwhile the audience stood and at the close of this brief ceremony an immense bouquet of pink roses was handed to the recipient of the evening's honors.

Professor F. R. Hutton, read several congratulatory messages: From John Fritz, in whose honor the medal fund was established; from William H. Maw, editor of *Engineering* of London; from the descendants of a business associate of Mr. Porter's in England, who happily signed themselves "all Hoyles;" from E. D. Leavitt; from the Iron and Steel Institute of England; and from both the Mechanical and Civil Engineering Institutes of England.

Debt Due Charles T. Porter

Professor Hutton then spoke in detail of the debt which the reciprocating steam engine owes to the pioneer work of Mr. engine owes to the work of Mr. Porter. This debt is grouped under five heads:

First, he saw a vision of the advantages that come from making the engine crank shaft turn at a high number of revolutions, whereby the weight of the motor per horsepower is reduced. From this vision has sprung the modern design of the high-speed engine for all purposes. The high speed involved the solution of difficult problems, owing to the necessity of starting and stopping heavy parts of the mechanism in each revolution. The second debt is for Mr. Porter's recognition of these problems.

The third debt, perhaps the most important of all, is that the standard of mechanical construction in the high-speed engine must be of the highest type. We owe him many manufacturing details which are commonplaces of modern practice.

The fourth debt is for an efficient condenser air pump, as used by Mr. Porter, attached directly to the engine and operated at a much higher rate of speed than was possible with the ordinary pump. The fifth debt is for two forms of engine governor adapted for high-speed service.

In the third address, Robert W. Hunt said it was scarcely conceivable that one could have witnessed in a single lifetime the remarkable development in the steel industry which he had observed since the time of the birth of the bessemer processes. These accomplishments were made possible by the application of a more rapidly acting power. The first power came from the slow-turning water wheel; later from the slow-speed engine. Faster movements were obtained through gears and belts. Among the first engineers to attach the rolling-mill engine directly to its train of rolls were John and George Fritz, but the speed of their short strokes was limited. Charles T. Porter was the first one to give the rolling-mill engineer a controllable, direct-connected, economical, high-speed engine.

Mr. Hunt referred to two engines in a rolling-mill plant in Troy, N. Y., in 1876. One set of rolls was driven by a walking-beam, low-pressure engine, taken from the steamboat "Swallow," a Hudson river boat, and the other set was driven by Porter-Allen engines. The contrast between the steamboat engine with a slow speed of 35 or 40 revolutions per minute, and Mr. Porter's little engines, humming away at high speed and accomplishing much greater results, was an educational sight. Iron and steel engineering owes a great deal to Charles T. Porter.

Era of Electricity and the High-speed Engine

In the closing address Frank J. Sprague recalled that in 1867, at the French exhibition, Charles T. Porter installed two Porter-Allen engines, the only high-speed engines exhibited. In the dozen years following, Mr. Porter built many engines with certain common characteristics, high piston speed and number of revolutions, solid engine bed and babbitted bearings, but there was no electric driving until a contract for engines for Philadelphia. In 1880, Mr. Porter installed a high-speed engine for Mr. Edison in his laboratory at Menlo Park and shortly after Mr. Porter was invited to construct for the Edison station at Pearl street, New York, the first of a series of engines for so-called "steam dynamos," each independently driven by a direct-coupled engine.

Mr. Sprague described the relations of electricity and the high-speed engine not as debtor and creditor, but rather a close partnership, an industrial marriage, one of the most important in the engineering world, that of prime mover and the electric generator. Here were two machines, destined to be joined together, economizing space, increasing economy, augmenting capacity, reducing investment, increasing dividends. Primarily, and largely due to Mr. Porter, the high-speed possibilities of the engine were commercially demonstrated and all honor must be paid and credit given to the man who first blazed the way for the present possibilities.

The former recipients of John Fritz medals, in the order of their award, were: Lord Kelvin, George Westinghouse, Alexander Graham Bell and Thomas Alva Edison.

Industrial Training by Apprenticeship

A Paper of Vital Interest and Containing Many Facts for Shop Managers as Presented to the National Metal Trades Association

BY E. P. BULLARD, JR.*

The financial statement of every organization, large or small, public or private, summarizes the assets and liabilities of that organization and details with more or less accuracy the items composing them. Good form in these matters forbids the inclusion of any but tangible assets and actual liabilities, yet every organization is dependent for its ultimate success on the personnel of its executive and working force, which may be an actual asset if efficient and aggressive, or a certain liability if inefficient and decadent.

Efficient organization is admittedly the keynote of success. All available resources are exhausted by the modern business manager for material to construct his product, for adequate means for financing his operations, and for energetic men to develop and execute his ideas.

We frequently hear that Mr. Blank is a great man—he is identified with a dozen or more large corporations—his name alone insures success to those who associate with him. We ask: How can he intelligently direct so many large and widely diversified industries? Why do his subordinates succeed and prosper? The answer is plain—he is a judge of men. He selects the right man for the place, reposes confidence in him, and through him dominates and controls an industry even as a general through his subordinates dominates and controls an army. He recognizes the fact that these men on whom he depends are an asset of his business, as much as is the capital invested, and makes provision to supplement them as necessity demands as he provides for a future supply of raw material or sufficient capital to carry out his projects.

He may be able, for a time, to secure all the men he needs from others who have trained and developed them, as he may be able to borrow money for the development of his business, but he will have to make both men and money before his success is assured. Every enterprise requires men skilled in the manipulation of its affairs, specialists in its particular line, versed in its various details and operations. The supremacy of an industry, a community or a nation, is dependent upon the skill and intelligence of its working people.

Prior to the recent business depression the utmost difficulty was experienced by employers of labor in securing sufficient numbers of skilled workmen to properly carry on their business. It was no uncommon experience for a concern to hire and discharge five men for every one retained. Really skilled men were not to be had at all in certain lines, and development was arrested on account of the inability to get desirable men. On the other hand, inefficient and unskilled help was plentiful.

It is admitted by all that we need more skilled men and that some means must be devised for developing the inefficient and unskilled so that they may be valuable to themselves, their employers, and the community in which they live.

Where can these men be found? The supply is inadequate to the demand. Our public schools do not educate for any particular trade; our colleges educate broadly but not specifically; our technical schools lay the foundation for engineering professions, but relatively few have an opportunity to avail themselves of the courses offered.

Ninety-five per cent. of the children who enter the public schools never reach high school, and less than twenty-five per cent. go above the fifth grade. This means that less than 6,000,000 out of 24,000,000 children enrolled in our public schools in 1907 will learn more than is taught in the primary grades.

The average child in the United States attends school for less than five years. What does this mean industrially? It means that if we are to have industrially intelligent workers that we must devise means independent of our public-school system for training and developing them.

What Would Apprenticeship Systems Do Toward Raising Our Standard of Industrial Intelligence?

Carefully devised apprenticeship systems, successfully operated in the majority of our factories would do much to augment the existing supply of skilled and efficient workmen.

The need to employers, of skilled workmen has already been pointed out, but not only are they necessary as producers—civilization itself has advanced along mechanical lines in such gigantic strides that there is a tremendous demand for, and a serious lack of, skilled men, simply to keep going the wheels of modern life, our towering buildings, our enormous ships, our great bridges—the thousands of mechanisms which are required to transport, to house, to feed, to clothe, to light, to heat and amuse our people, present an immense field for trained men.

They would insure workmen being educated along *definite lines*, thereby meeting the demand for competent leaders and executors. It is of the utmost importance that those who are to occupy executive positions should have familiarized themselves with the various details of the work coming under their supervision; they should be able to decide whether the judgment of their subordinates is sound, whether the operations required to make some particular piece are correctly performed, whether the quantity and quality of production for which they are responsible is of the required standard. This knowledge can be gained only by actual contact with the work and a personal study of the conditions under which it is performed.

Apprenticeship systems would offer to young men of limited means, who would otherwise be forced into that large and growing class of unskilled labor an opportunity to learn a trade. Poverty, disease and crime are frequently the result of ignorance and environment. Every individual, workman or capitalist, is buoyed up, spurred on, by hope.

Picture to yourselves the unskilled workman, earning the minimum wage on which a man can live and support his family. His greatest anxiety is concerning steady employment for himself, his one hope, an opportunity for his children. Where is this opportunity to be found? Not in an education which yields no immediate return, for he cannot support them during that period. His sons must find work as soon as the law will permit, and it must be work which will support them from the beginning, for the father cannot. This means that these boys must take situations which require little, if any, skill; situations which pay practically as much at the beginning as at the end. Unskilled work and unskilled wages, with no chance of advancement in either skill or remuneration. So they go on through all their lives, bequeathing to their sons what their fathers bequeathed to them—ignorance and poverty, possibly disease and a tendency for crime. What have they to hope for, to buoy them up, to spur them on? Give boys of this class an opportunity to learn a trade, to be skilled workmen and in demand, rather than unskilled and in no demand, and you solve a large problem in American economics. Apprenticeship systems offer this opportunity.

*President, Bullard Machine Tool Company.

DO APPRENTICESHIP SYSTEMS PAY THE EMPLOYER?

Most emphatically YES. Many large and successful concerns which have had apprenticeship systems in operation for a period of years are unanimous in their statements that apprenticeship systems do pay. If properly instructed and intelligently directed, their employment is more profitable than the employment of the so-called skilled workman who has been available in the past. Apprentices pay as producers during their term of service; as competent skilled journeymen when they have completed their course, and as industrially intelligent foremen and executives later on. Those boys who leave at the termination of their apprenticeship become staunch supporters of the mother-shop, always ready to say a good word for it; as loyal as college graduates to their alma mater, an unequaled advertising medium.

DOES IT PAY THE EMPLOYEE TO SERVE AN APPRENTICESHIP?

I firmly believe that it does. He is raised from the ranks of unskilled labor and given an earning power which he could not otherwise command. He is taught to work intelligently and to apply his mind to his work, thus increasing his opportunity for further development and advancement.

WHAT PROVISIONS SHOULD APPRENTICESHIP SYSTEMS MAKE FOR THE EMPLOYEE?

Apprenticeship systems should provide for a proper term of service to insure ample time for thorough instruction. A distinct proportion should exist between the period of time required to learn a trade and the degree of skill required in the trade.

Apprenticeship systems should provide for sufficient remuneration to support the apprentice during his term of service. Applicants for apprenticeship courses will, in the majority of cases, come from the working classes, from the farms in many instances, and must of necessity have an opportunity for self-support during their period of apprenticeship.

Apprenticeship systems should provide instruction in the technique of the trade and allied studies. The average boy begins to learn his trade between the ages of 14 and 17 years. He has not advanced beyond the fifth grammar grade, and probably could not pass an examination on any subject which he has studied. He has not been taught to reason nor apply such knowledge as he has. If he is to become a skilled mechanic, it is essential that he should be well grounded in the elementary studies which are allied to his trade. He should be taught at least the mathematics of his work, the technical terms usually employed, and sufficient reading, writing and spelling to supply the deficiencies of his common-school education

Apprenticeship systems should provide instructions in the manipulation and care of the appliances of the trade. I believe there are many here who either own or are responsible for valuable manufacturing equipment which is practically at the mercy of unskilled employees or uninstructed apprentices. The average employer would deny this statement, believing as he does that the foreman supervises and instructs his workmen and apprentices. As a matter of fact, the foreman seldom has time to explain to each man or boy such items as the necessity and economy of sufficient lubrication, the function of each mechanism, and the means which should be employed to obtain the most economical results. Being occupied with what are to him more important matters he is content to let the boy find out these things for himself—an expensive and inefficient system. Every large plant maintains a repair department at a cost which is no inconsiderable portion of its operating expense. Instruction in the care and manipulation of the appliances which it uses would do much to reduce this item.

Apprenticeship systems should provide for the fostering of a spirit of ambition and desire for increased knowledge. Let the apprentice see that his diligence will be rewarded, that he may in time be foreman, superintendent, manager, if he applies himself to his work, and no difficulty will be experienced in securing all the boys required. If there is anything in a boy this will bring it out; if not, get one who will appreciate his opportunities.

As the employees of any industry may be divided into two classes, producers and nonproducers, workers and executors, and as there is need for trained men in each of these classes, I recommend that apprentice courses be arranged to meet these conditions. Let the boy who is bright and ambitious and who otherwise shows the necessary qualifications become more than a mere workman, have an opportunity to learn the full trade, including instruction in the studies allied to the trade. Impress upon him the fact that he is given an exceptional opportunity, and demand in return exceptional interest and effort.

Advance these boys systematically through the course and weed out such as are not up to a high standing. Select your executives as far as possible from among their number and thus show them that their diligence and efforts will be rewarded.

As the workers outrange in numbers those having executive ability, it is fully as important that as much attention be paid to the development of the latter as the former. Relatively few applicants for apprentice courses have any expectations of ever becoming more than skilled specialists. Why then waste time and money in teaching the full trade to a boy who has neither the intelligence nor ambition to become more than a mere specialist? Provide special courses for these boys covering the various branches of the trade; make the time of service relatively short and wages high as compared to the full apprentice course; give graduates of these special courses an opportunity to learn the full trade later on if they show special ability, allowing credit for the time already served on the special course. The full apprentice course would train boys to fill executive positions. The special courses would develop skilled workmen with a minimum expenditure of time and money.

The apprentice school is a necessary adjunct to any well organized apprentice system. Few concerns are large enough to support a school of their own as is done at Lynn and Schenectady, and not every community is prepared to establish a technical school such as Winona or Cincinnati University. Fortunately, however, like industries usually locate in the same neighborhood, so that it is possible for manufacturers employing a similar class of labor to coöperate in the establishment and maintenance of apprenticeship schools.

In Bridgeport, Conn., this has been done very successfully. The members of the local manufacturers' association, working in conjunction with the Y. M. C. A., have established a school for apprentices, who attend class two hours per day five days per week. The boys are paid regular wages for the time they spend in the class room, and the entire expense for the instructor, who is especially employed for this purpose, is borne by the manufacturers who have boys in the school.

The Y. M. C. A. building was selected as it is well equipped, and is provided with class rooms and all facilities for carrying on the work. The courses are laid out by a committee composed of manufacturers, and the work is directly under their supervision and control. The expenses are nominal, and the results secured thus far are satisfactory.

What is the attitude of labor unions toward the apprentice system? No labor union having the welfare of the workingman at heart can be opposed to well organized and well conducted apprentice courses. As well be opposed to our public-school system on the ground that education is dangerous.

The labor union which sets its seal of disapproval upon well organized and well conducted apprentice courses admits its ignorance of industrial and social developments and requirements. It cannot have the welfare of its members nor the working classes at heart. It should be recognized as hostile to the best interests of employer and employee alike and should not be tolerated in any community. Labor unions can in no way more conclusively show their interest in the welfare of the workingman than by indorsing and furthering the adoption of apprenticeship systems and schools.

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The Patent Office and the Inventor

We receive from time to time communications from our readers which indicate a serious misunderstanding of the proper function of the Patent Office in examining applications and issuing patents, and the frequency with which these complaints—for such they are—come to us indicates the desirability of a clear statement of what the Patent Office attempts and what it is possible for it to do.

The most common of these complaints relates to the fact that after the examination and the issuing of a patent it is frequently found to be invalid, and there is a widespread feeling that, having taken the applicant's money and issued a patent after an examination, the Government should in some way guarantee its validity.

This idea shows an entire failure to realize what it is possible for the examination made by the Patent Office to include. The examiners of the office have great files of prior patents, both American and foreign, and it is clearly not possible for the examination to go much beyond the consultation of these files. Many inventions have been made and published in periodicals without being patented, and such publication is just as good evidence that an invention, when it turns up in the Patent Office from a later inventor, is not new, as the appearance of the same invention in the examiners' files of patents. It is, however, clearly impossible for the examiners to search all periodicals relating to a given line of invention before issuing a patent, and it is thus necessary for an inventor to assume the risk that such prior publication in periodical form will be discovered after his patent has been issued.

Many times the examiners are confronted with a still more impossible case, namely, that in which an invention has been made and used without any publication of it. In such cases it is clearly impossible for any conceivable system of examination to discover the existence of the older invention.

Most cases in which patents are found to be invalid turn, we believe, on one or both of these conditions: the contestant of the patent putting in evidence information of the previous use of the invention, this evidence being sometimes in the form of the old publications of it, and sometimes in the form of verbal testimony.

Admitting for the moment that the guarantee of a patent by the Government is a legal possibility, it could thus only lead in many cases to the granting of patents to later inventors. It might, and often would, give a monopoly of a device which was already in commercial use by others than the applicant and thus deprive the first inventors of the use of their own inventions.

Moreover, the examiners are necessarily human, and in granting patents they cannot fail at times to make mistakes and grant those which infringe prior patents. To guarantee a later patent would in such cases do the original inventor gross injustice. It is for the doing of justice between individuals that courts of law exist. When one man considers himself aggrieved by another the courts exist in order that he may appeal to them and have the case settled, and while this frequently involves hardship and expense, it is the only way that civilization has found to dispose of such disputes.

The right of appeal to the courts is inherent in citizenship, and the call for a government guarantee of the validity of patents involves the unthinkable condition that the decision of a patent examiner shall stand between a citizen who considers himself aggrieved and this right of appeal.

Another frequent complaint relates to the issuing of patents for worthless inventions, the feeling being that the Government should not take an inventor's money and give him a patent for an invention which is obviously worthless.

The best available, although by no means always a good, judge of the advisability of patenting an invention, must be the inventor himself. Presumably he knows more about the demand for an invention in any particular field than the examiner can. A really competent inventor would certainly resent any suggestion from an examiner that the latter knew his business better than himself. Great numbers of inventions possess a value known only to those engaged in the industries to which they relate, the patent papers giving no indication whatever of their value, and the exercise of discretion by the examiner in such cases would often lead to serious hardship.

If an inventor is willing to spend his money for a patent, the Government can do nothing else than issue it to him, provided the invention is found to be novel. The only thing that the Government can do is to examine into the novelty of the invention, and even this it can only do imperfectly, as we have already indicated.

We are in this case far from defending the shortcomings of the Patent Office. Its work is not as well done as it should be and might be, but the theory of its work is, we believe, sound, and its shortcomings are due to the fact that the practice does not come up to the theory. Many of the complaints made about the work of the office are, however, based upon the assumption that the Government should take care of the individual and even protect him against himself. This is not only impossible, but undesirable. What is needed is not more Governmental paternalism, but more good sense on the part of inventors.

Moreover, with all the shortcomings of the Patent Office admitted, their effect is dwarfed by the faults of the legal procedure which attends patent litigation, for

it is against this and not the Patent Office that the chief grievance of the inventor lies. This procedure is so complex and is so full of pitfalls that the defense of a patent in court is without doubt the most hazardous piece of litigation known. There is, we believe, no class of litigants of whom so small a proportion receive satisfaction as patentees, while the cost and delays of patent litigation are beyond all reason. The collection of damages from an infringer is the rarest of rare things, the stopping of further infringement being all that the litigant can hope for and more than he can reasonably expect.

It is this condition which favors infringement by, in effect, throwing protection about the infringer, our patent laws being practically nullified if, indeed, they are not actually reversed from their intended purpose. So far from favoring invention it is not far from the truth to say that they favor and are a direct encouragement to infringement. There is nothing in our public life that is so anomalous as the existing condition of patent litigation.

Annual Meeting of the National Metal Trades Association

The eleventh annual meeting of the National Metal Trades Association was held at the Hotel Astor, New York, April 14 and 15, and was largely attended. The papers were particularly interesting, beginning with the one on "Industrial Training Through Apprenticeship Systems," which is given in another column.

A committee was appointed to investigate the question of apprenticeship systems and to report or recommend at the next meetings such forms and methods as appear to be suitable. The committee consists of E. P. Bullard, W. A. Viall and Frank North.

The other papers were, "Profit Sharing," by R. T. Crane and N. O. Nelson; "The Premium System of Paying for Labor," by F. C. Blanchard; "Industrial Peace," by Hon. C. P. Neill; "What the Workingman Wants from the Employer," by James Wilson; "Employers' Liability Insurance," by Hon. Epaphroditus Peck, and "The Labor Question," by David Gibson.

The following officers were elected for the coming year: H. P. Eells, president; J. H. Schwacke, first vice-president; H. W. Hoyt, second vice-president, and William Lodge, treasurer.

The whole tone of the convention was particularly gratifying in its optimism and the spirit of helpfulness and fairness that pervaded the papers presented as well as the discussions. In his paper on "Profit Sharing," R. T. Crane gave his experience which had its beginning many years ago and was based on the English plan of the late John Bright. This was not satisfactory and was replaced by an opportunity to buy stock in the company, but this also failed. The present plan and the one he now advocates, is the distribution, as a gift, of a bonus based on the wage rate, this now being fixed at 10 per cent. in his own company. They also maintain a sick benefit, pension fund and doctor's service for both men and women.

N. O. Nelson has a different plan, which has been running for 23 years, during which time there have been no losing years. The present plan is to put aside 6 per cent. interest on the capital employed and divide the remainder between the employees and the customers.

Under title of "The Premium System," T. C. Blanchard gave his experience with this plan on small work. This included timing of operations, the encouraging of team work so that each member of it gets his proportion of the increased production. William Lodge outlined the extension of this plan which they have adopted, and that includes everyone from the superintendent down to the office boy. It makes it profitable for the foreman to help and encourage the drill boy and the slow workman, and to keep all departments up to the premium rate. Half of the premium goes direct to the men, the other half going to what is classed as unproductive labor, such as the pattern shop and drawing room, in proportion to their output. A part goes to the superintendent and his assistant, while another portion goes to the establishment of a pension fund, which will be available to any man who has been in their employ for 25 years and which will be in shape to take care of any demand before it is called upon, being then able to meet any call from the interest of the fund.

W. H. Viall voiced the sentiment of many by declaring that the basis of all harmonious shop conditions was a square deal and a sympathetic treatment of the subject.

James Wilson, president of the Pattern Makers' League, told "What the Workingman Wants from the Employer," and claimed that organization was just as necessary on one side as the other, and that differences could usually be settled by recognizing each other as representatives of a body and carefully considering all phases of the situation.

Hon. Epaphroditus Peck, of Yale, outlined what he believed would be the probable changes in the laws of employers' liability, and felt sure that the existing laws must give way to those which are more in keeping with modern humanitation lines. The United States, at present, must be classed with Russia and Turkey, and behind all the rest of the world when it comes to liability laws. The modern tendency is to make the cost of accidents in any industry a burden to that industry and add it to the overhead charges the same as taxes or insurance. This would avoid the expensive damage suits that always engender hard feeling and perhaps opens the way for a liability insurance that shall aid the men instead of standing as a barrier between them and the employer.

The dinner of Wednesday evening was one of the most successful that we have ever attended, our measure of success being the number of those who remained until the conclusion of the program, which did not take place until midnight, and which saw so few desertions that they were not noticeable.

The speakers were Hon. Seth Low, president of the National Civic Federation, who spoke upon the activities of the federation, C. D. Traitel, president of the New York Building Trades Employers' Association, who spoke upon the success of trade agreements and the acceptance of the closed shop in the building trade of this city, and Rev. S. P. Cadman, of the Central Congregational church, Brooklyn, who spoke of the larger aspects of the labor question as seen by a minister who is a graduate from the ranks of labor. The entertainment features were entirely musical and without the vaudeville features which attend many dinners of this character.

New Publicatsons

AIDS TO SHIPPERS. 60 9x7-inch pages; indexed. Oelrichs & Co., 5 Greenwich street, New York City. Gratis.

This little book, sent out by the forwarding department of the company named, is a compilation of most useful data for the American exporter and manufacturer doing a foreign business. Practical points are treated in a practical way; they cover questions that arise, first, when quoting in answer to a foreign inquiry, and, second, when preparing a shipment to fill a foreign order. To show the nature of some of the admonitions we quote: "Too much stress cannot be laid upon the care that should be exercised in packing merchandise *exactly in compliance with the wishes of the purchasers*, no matter how trivial they may seem." —"It is an established fact that the marking of packages also plays an important part in export shipping."—It is important that all shipping documents . . . should be forwarded to consignee *as promptly as possible*." Not the least interesting is an extensive tabulation of foreign weights and measures, which is interesting in another way as it is an addition to the constantly growing volume of evidence regarding the continued use of old nonmetric units in so-called metric countries. Thus, the first 10 countries which appear in the table are all those which we are accustomed to hear use the metric system exclusively. Of course, evidence of this kind cannot be brushed aside with a sneer much as the metric experts would like to.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

Large Milling Machine with Auxiliary Head

The engraving shows one of the standard horizontal-spindle milling machines made by the Ingersoll Milling Machine Company, Rockford, Ill., with the addition of a vertical-spindle attachment and a special auxiliary saddle bolting onto the main saddle and carrying a horizontal spindle especially for face milling. The main saddle carries the horizontal spindle which drives the arbor with a clutch on its face and is supported by two arbor supports on the rails. The center support is used only with a gang of cutters, and is removed when a wide slabbing cutter is needed.

Either a vertical or horizontal cutter can be carried in the head at the left, the object of the auxiliary horizontal spindle being to bring the milling cutter considerably below the main horizontal spindle so that it can face off the side of such work as shown in Fig. 2, which would be impossible with the main spindle, owing to its proximity to the cross-rail. These auxiliary spindles are driven by gearing in both cases, making a very compact and efficient auxiliary head.

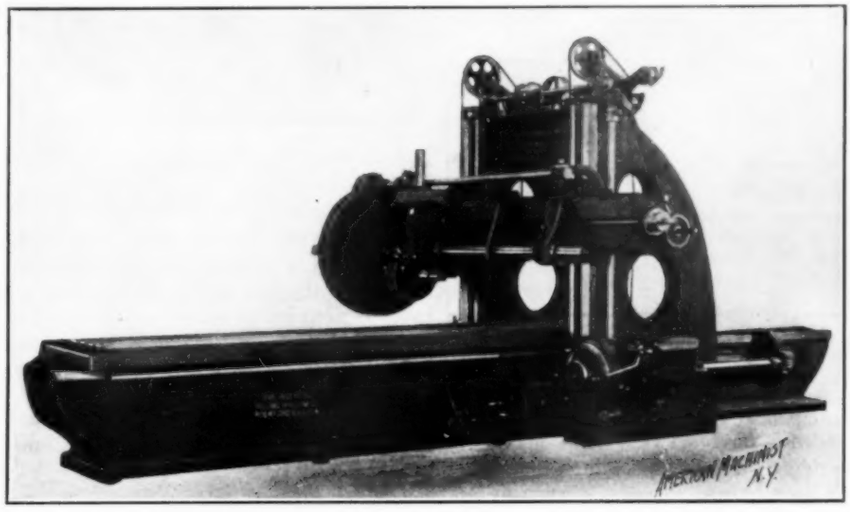


FIG. 1. MILLING MACHINE WITH AUXILIARY HEAD

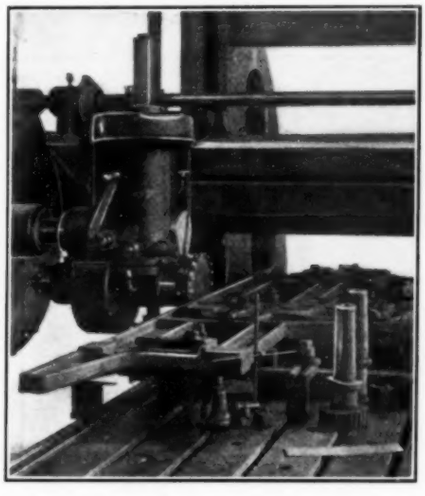
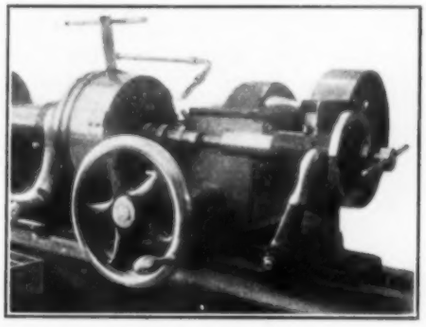


FIG. 2. AUXILIARY HEAD AT WORK

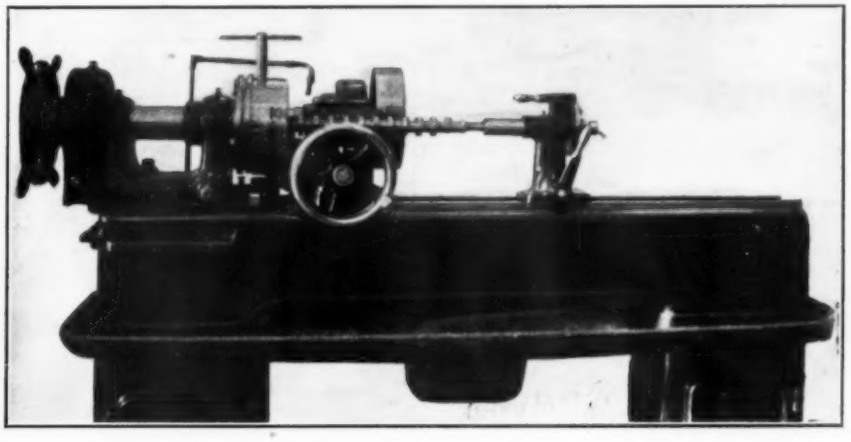
Profile Milling Machine for Cams

The machining of cams for operating the valves in internal combustion engines is something of a problem, whether they are made solid with the cam shaft or made separately and keyed in place. There is a tendency in many quarters to make these solid with the shaft by having them turned down as collars in some sort of a rapid-reduction lathe and afterward machining the cams to shape.



WORKING UP CLOSE TO CHUCK

In this machine the cam shafts are taken as they come from the lathe, gripped in the chuck and supported by the indexing tailstock at the other end. Back of the chuck is the master cam which controls the movement of the slide carrying the milling cutter and insures the cam being cut to exactly the right shape. After one cam is cut the shaft is indexed around by the dividing head which is fastened to the cam shaft and slides along the bed

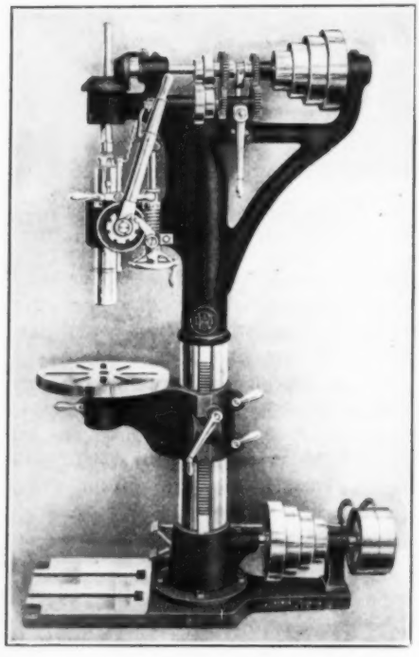


AUTOMATIC CAM-MILLING MACHINE

as the cam already cut is fed into the hollow spindle. This insures the cams having exactly the correct relation to one another and is an economical as well as accurate way of producing them. The capacity of the hollow spindle is 2⅝ inches, a cam shaft 44 inches long can be handled and the diameter of the cutter is 2½ inches. These machines are built by Webster & Bennett, England, and sold in this country by Schuchardt & Schütte, 90 West street, New York.

Robertson 21-inch Drill

Perhaps the most noticeable feature of this drill is the square spindle which slides through the driving gears and is 1⅛ inches across the side. This does away with all feathers or keys and may be compared with the practice of automobile builders in making their transmission



NEW 21-INCH DRILL PRESS

boxes. As these transmit many times the power required by a drill press of this size, there can be no question as to its strength. Either a geared or belt feed can be used, which drives through the double worm to the quill surrounding the drilling spindle. An automatic knock-out is provided to disengage the feed at any desired point by relieving the clutch shown behind the lever used for hand drilling, when this form of feed is preferred. For heavier feeds by hand the wheel and worm shown between the spindle and the column can be used for this purpose.

The spindle has a vertical movement of 10 inches, the greatest distance between spindle and table is 23½ inches, and to the base 33 inches. The spindle has a No. 3 Morse taper. The table is 15¾ inches in diameter and has a vertical movement of 14 inches. This machine is made by the Robertson Drill and Tool Company, Buffalo, N. Y.

Chuck with Differential Screw

This is somewhat of a departure from the usual construction of an independent lathe chuck and one that has several interesting points. As shown in Fig. 1 the stud *A* has a taper end which screws into the chuck body, and a plain portion between this and the main screw or thread so as not to afford a lodging place for chips. This stud has a right-hand thread,

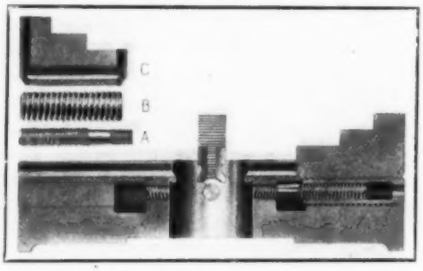


FIG. 1. CONSTRUCTION OF CHUCK

as shown at *A* (erroneously shown left-handed in the other view) and this fits the inside of the main screw *B*, which has a left-hand Acme thread on the outside. This screw fits into the jaw in the usual way and has a square hole in the outer end to receive the wrench.

As can be seen from the jaw which is in place, the stud *A* forms a guide for the main screw *B* and as one thread is right-hand the other left-handed, one turn of the screw moves the jaw a distance equal to the pitch of both threads, giving it a rapid movement. The threads are so proportioned as to give a very powerful grip and also a large wearing surface to insure durability. Most of the wear, however, comes on the stud or small screw which can be very easily and cheaply renewed should it become necessary.

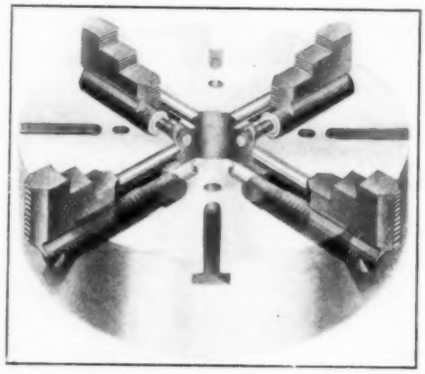


FIG. 2. SHOWING T-SLOTS IN FACE OF CHUCK

Fig. 2 gives a view of the complete chuck showing the jaws reversed so as to increase its capacity and it also shows the T-slots in the face of the chuck which are very convenient at times in holding work that needs to be secured at several points. On the larger chuck these slots have an opening clear through to the back so as to enable the use of through bolts. They are manufactured by the Carter Chuck Company, St. Louis, Mo.

A New Portable Drill

The illustrations show two forms of a new portable drill just brought out by the Coates Clipper Manufacturing Company, Worcester, Mass. The smaller size can be used either as a breast drill, or in

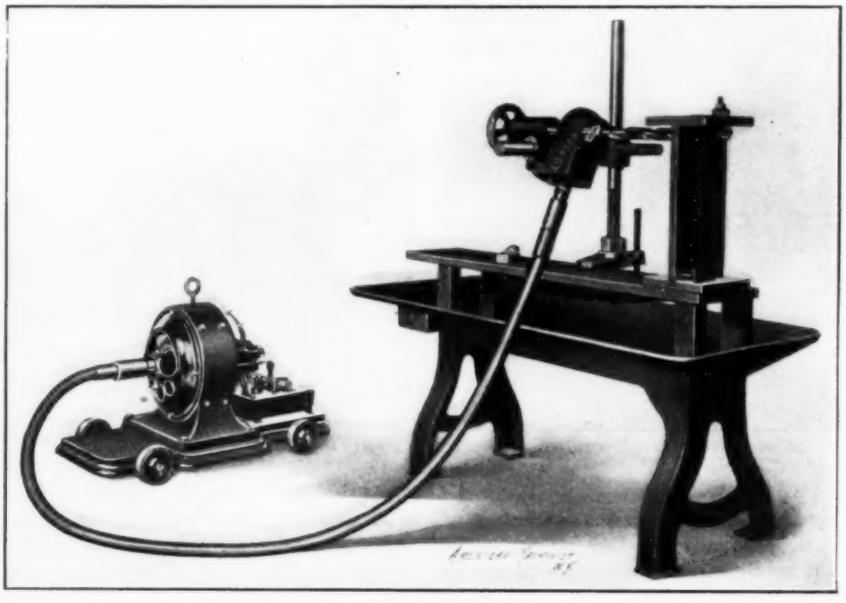


FIG. 1. COATES DRILL WITH MOTOR ON TRUCK

connection with a brace or "old man," and weighs only 12 pounds complete, as shown, equipped with one of the new Jacobs drill chucks and the ¾-inch drill.

These drills have three changes of speed, obtained by a very compact gear box in the rectangular part of the frame, by a cone of gears and a sliding key after the manner of many feed boxes. It is a very small gear box and evidently a very efficient one, if we can judge by the tests made in the writer's presence. With the regular motor equipment the larger machine drove a 1¼-inch drill through a block of cast iron as fast as a man could turn the hand feed wheel. Later a ½- and finally a ¼-horsepower motor drove this same drill into the same block, although, of course, this required a finer and more careful feeding. This indicates the combined efficiency of both drill and motor, as while it must have been greatly overloaded it neither sparked nor heated.

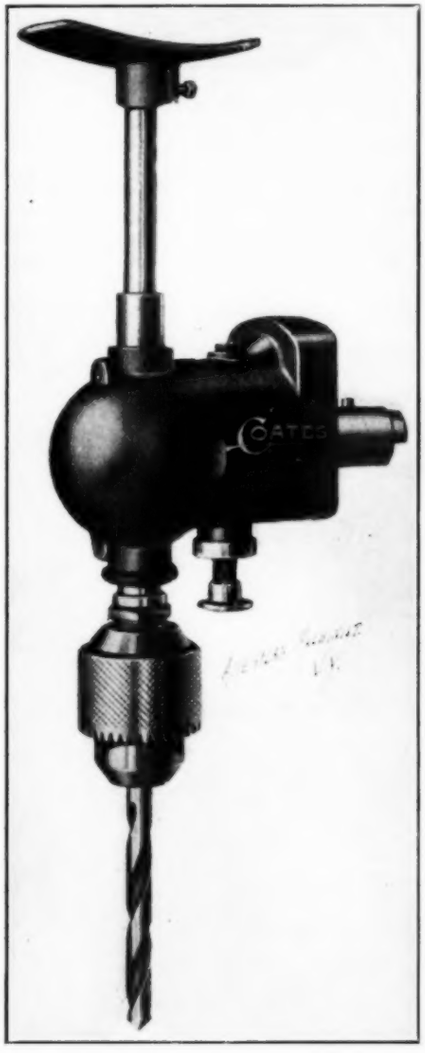


FIG. 2. USED AS A BREAST DRILL

Needless to say these are driven by the Coates flexible shaft between motor and drill, and the combination is one that will appeal to all who have use for portable tools of this kind. It might be said further that there are many more opportunities for using such portable tools to advantage than are generally realized, and that they can be used in many ways that are not apparent when such a machine is installed.

A Roller Thrust Bearing

This bearing was developed by the Reeves' Pulley Company, Columbus, O., to meet the requirements of its variable-speed transmission. As can be seen, this

FIG. 1. REEVES ROLLER THRUST BEARING

consists of six good-sized rollers held in a cage, perfectly true at all times, the design insuring permanent alinement during its life. One end of the rolls is spherical to conform with the retaining ring and serves to hold them in a true position. As the cup and the rollers are constantly changing their relative positions, the wear is evenly distributed.

The spacing cage is made of bronze, and simply separates the steel rollers. The rollers run between two hardened-steel

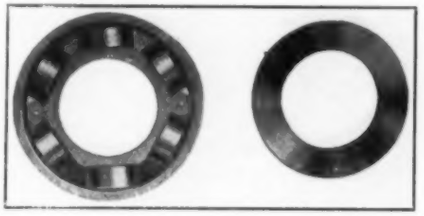


FIG. 2. WITH ONE RACEWAY REMOVED

raceways, one bored large to clear the shaft, the other revolving with the cast cup and the shaft, thus avoiding all tendency to cut. The assembled bearing is shown in Fig. 1 and the rolls in Fig. 2.

Schuchardt & Schutte Gear Hobber

In describing the gear-hobbing machine of the Schuchardt & Schütte Company, we confused it with their regular line of gear hobbers, whereas it has been designed specially to hob teeth of street-car gears. The first machines were built for the Allgemeine Electricitats Gesellschaft, of Berlin, and on gears with 69 teeth, 4½-inch face and 3 diametral pitch, the time was reduced to two hours each, at the same time securing a better gear than before.

The inventor, Herman Pfanter, has given special attention to the hobbing of special gears, and is one of the pioneers in this line of work.

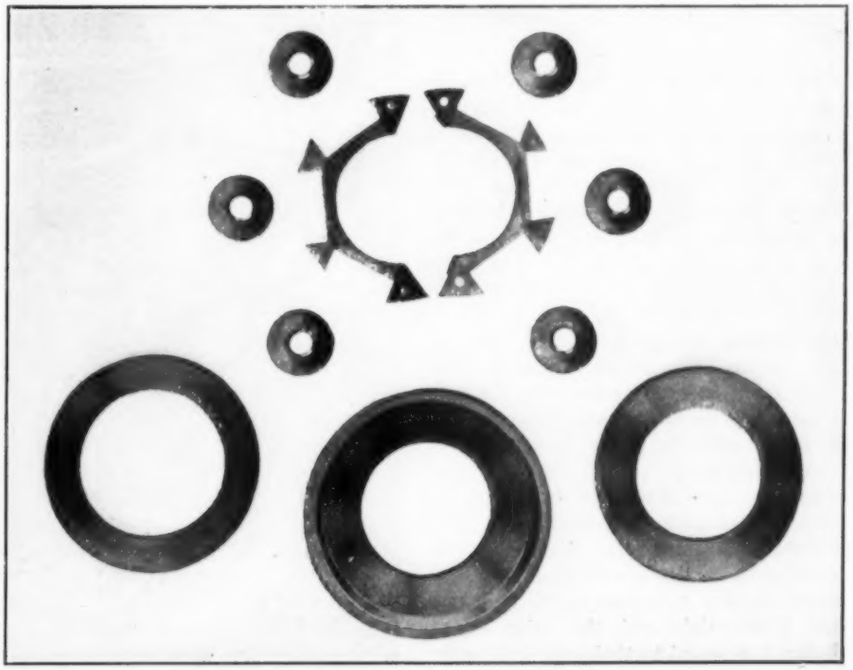


FIG. 3. THE BEARING IN DETAIL

Combination Square

This tool is composed of two steel rules, one having a clamping device, as shown in Fig. 1, and the other having a slot, through which passes a thumb screw to fasten the clamp, and against the side of which an eccentric pin bears to keep the rules square with each other. The slotted rule slides back and forth and various devices can be formed as follows: Fig. 1, depth gage; Fig. 2, try square; Fig. 3, hook rule; Fig. 4, T-square; Fig. 5, vernier caliper. These can be augumented by the use of center square head, bevel protractor, level, etc. This tool is the invention of W. F. Dissell, 9700 Gibson avenue, Cleveland, Ohio.

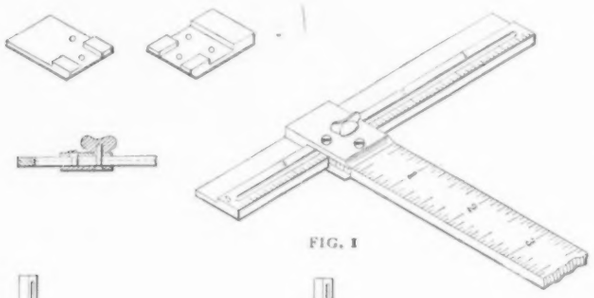


FIG. 1

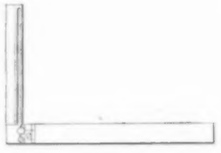


FIG. 2

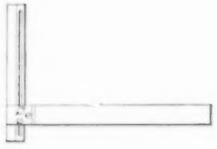


FIG. 3

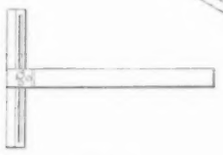


FIG. 4

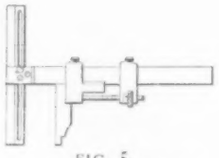


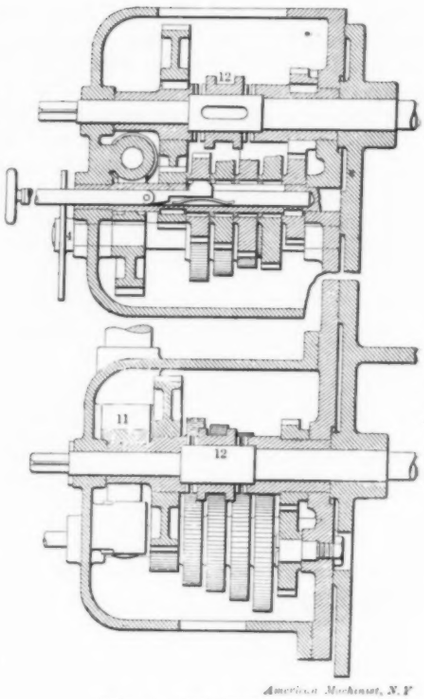
FIG. 5

American Machinist, N.Y.

COMBINATION SQUARE

drawn, the belt shifted from 8 to 7 and the table turned by the worm into the next position.

The spindle details, Fig. 3, need little explanation. Both bearings have tapered bushings for taking up wear. The cutters are held in place by the through bolt shown. A stop is provided on the side for regulating the depth of cut and the small cross-handled screw *A* provides an easy way for locking the gib and the head at any desired point.



American Machinist, N.Y.

FIG. 4. THE FEED BOX

The feed box at the end, shown in Fig. 4, derives power from the right-

Automatic Milling Machine

This was designed for milling the jaw grooves in chucks, three-jawed chucks in this case, without the need of an operator except for setting the work. A general idea of the machine can be had from Fig. 1. The table, carrying the chuck to be milled travels back and forth on the bed, under control of the stop 1, and the shifting lever 2, which is connected to the clutch rod 3, as can be seen in Fig 2. The milling spindle is of the vertical type, details being shown in Fig. 3. The table is turned to bring the next slot into position, by the mechanism shown in Fig. 2, which gets its power from sprocket 4 and shaft 5.

In Fig. 2 we have the details of the carriage and its turning mechanism. The lower shaft 5, driven by the chain from sprocket 4, carries a wide-faced pulley 6, from which a belt runs up to pulleys 7 and 8, one tight and the other loose. Pulley 7 is keyed to the shaft driving the worm 10, and when the milling cutter is free of the slot, the locking bolt 9 is with-

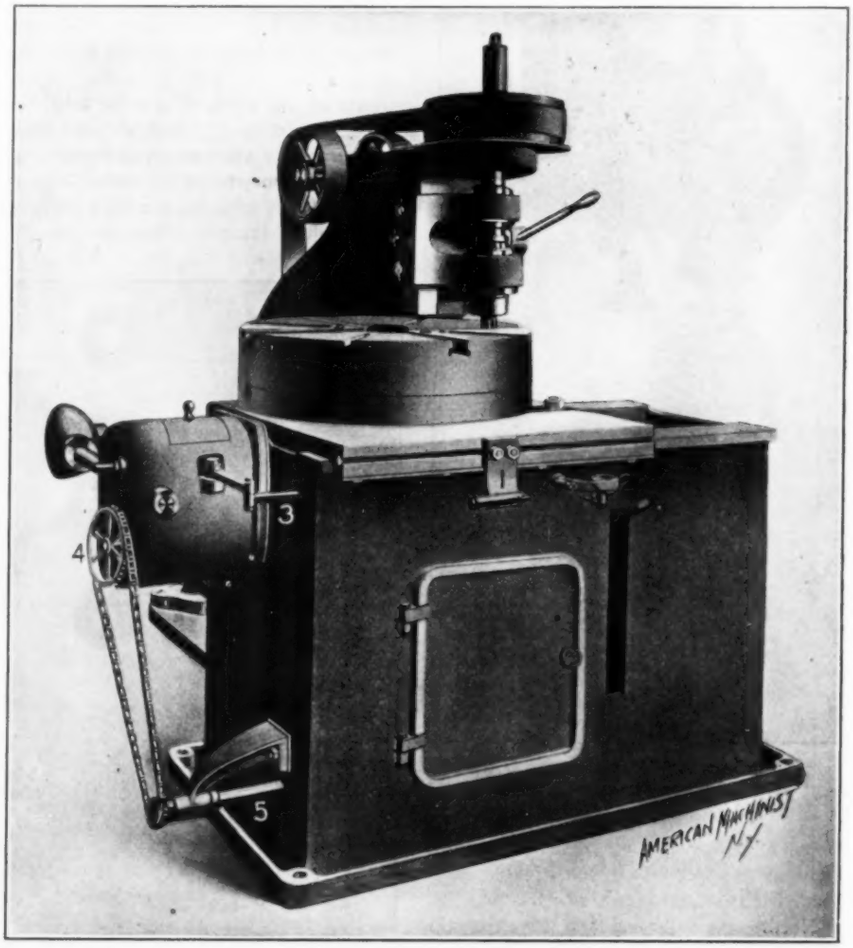


FIG. 1. AN AUTOMATIC MILLING MACHINE

angled shafts at the back, through the spiral gears 11. The cone of gears has the usual sliding key as shown, and each step gives both a slow and fast feed by means of the clutch 12 and the gears at end with which it meshes.

When the cutter feeds into the work from the outside, the slow feed is used, but on reaching the end of the slot, the clutch 12 is thrown, through the trip lever 2 and rod 3, into the fast feed and the center returns through the cut at a higher speed, leaving it in good condition.

When the last groove has been cut the main belt is thrown on to the loose pulley and the man is notified that the machine is ready for another piece of work.

It is something out of the ordinary in milling-machine construction and its usefulness need not be confined to milling chuck bodies of any kind, but can be extended to many other fields. We are indebted to the makers, Nielsen & Winther, Copenhagen, Denmark, for the illustrations and information concerning it.

Official Test of the Swedish Gages, Made at the British National Physical Laboratory

A set of these gages, 81 in number, from 0.05 inch to 4 inches in thickness was tested for the British admiralty by the British National Physical Laboratory.

They were compared with the laboratory standards at a temperature of 62 degrees Fahrenheit. The tests were made on the middle parts of the measuring faces. Out of the 81 pieces only *three* were not to size, viz., 0.113 inch measured 0.11299 inch; 0.139 inch measured 0.13899 inch; 4 inches measured 3.99999 inches, each one being apparently 0.00001 inch under size. The gages were also measured toward the ends of the faces, and in all cases the measuring faces were found to be parallel within 0.00001 inch.

On page 394, Vol. 30, Part 2, of the AMERICAN MACHINIST mention was made of a test made in the presence of an editor of the AMERICAN MACHINIST. Two gages were wrung together and it took a force equivalent to 31 pounds per square inch, or over two atmospheres to pull them apart. This test was made with crude apparatus. Another similar test with better apparatus was made recently in Sweden where two blocks, wrung together in the same way, sustained a weight of 37 kilograms, approximately 80 pounds. This corresponds to a trifle over 11 atmospheres.

An interesting demonstration was recently given in England of an electric-generating plant operated by a windmill. The wind wheel was 16 feet in diameter, and was mounted on a tower of 50 feet hight. Three tails were provided, one at the side being fixed, and the other two adapted to be rotated on a horizontal axis, so that when they were turned into the vertical plane they would hold the wheel into the wind, and when turned in the horizontal plane, the fixed tail would throw the plane of the wheel in the plane of the wind. The two movable tails were arranged to swing out of the vertical position, automatically, when the velocity of the wind rose above a certain amount. A two-kilowatt generator was driven by the wheel at speeds varying from 800 to 1600 revolutions per minute.—*Scientific American.*

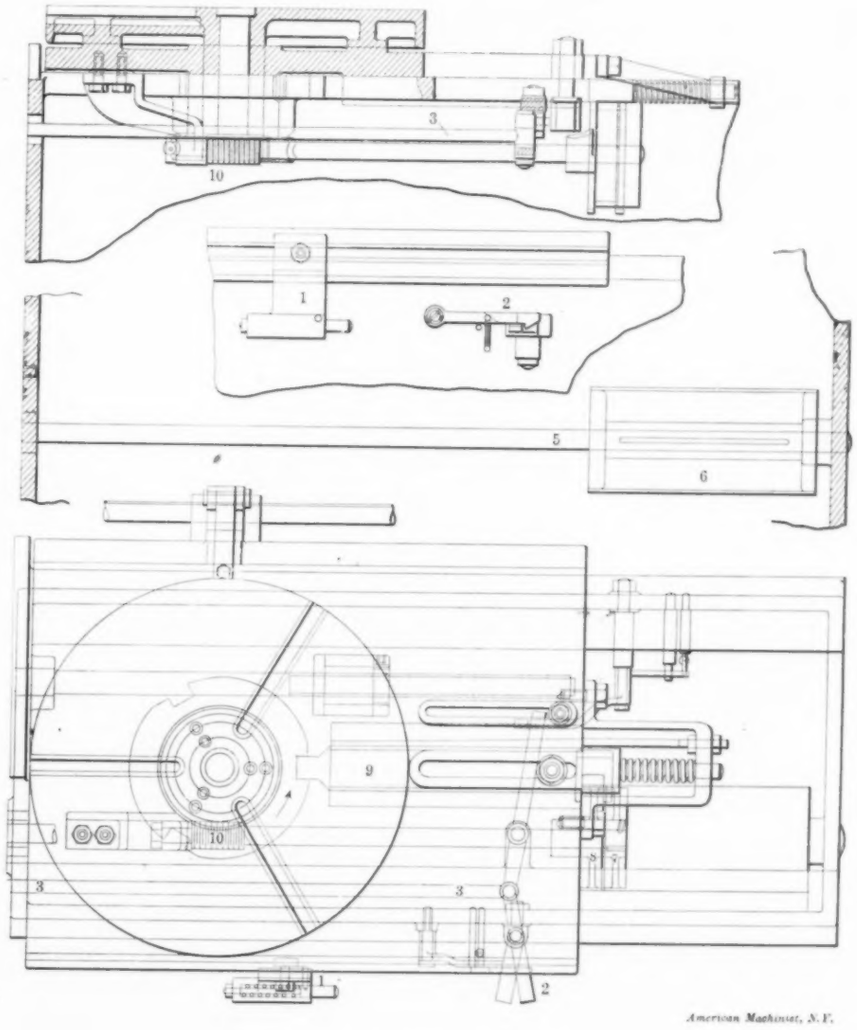


FIG. 2. THE CARRIAGE AND ITS DETAILS

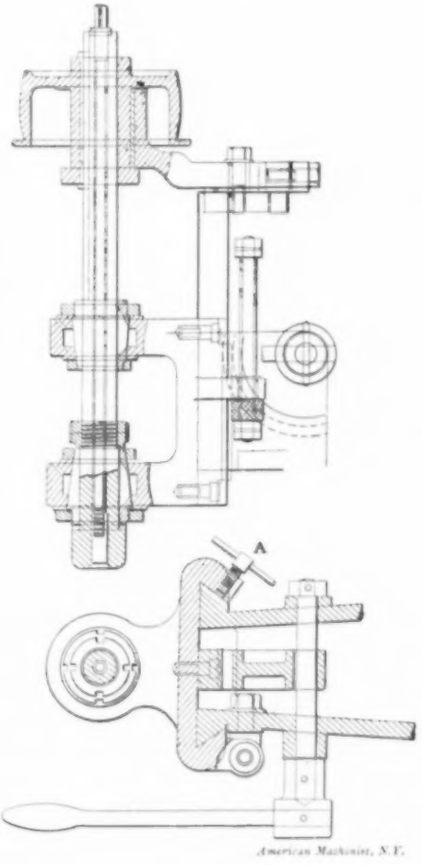


FIG. 3. DETAILS OF THE MILLING SPINDLE

Activity of the Museum of Safety and Sanitation

The Executive Committee of the Museum of Safety and Sanitation, of 29 West Thirty-ninth street, N. Y., has detailed Dr. Wm. H. Tolman, the director, for field work, and he will start May 1 on a lecturing tour. Chambers of commerce manufacturers' associations, engineering, insurance and architectural societies, railway and other clubs, may avail themselves of this illustrated exposition of devices and methods for reducing damage suits and preserving efficiency, for the cost of the lantern operator ($10), if not too far removed from the itinerary.

Personals*

M. E. Dewstol, Birmingham, Ala., has been appointed as representative of the Bullard Machine Tool Company in the Alabama and Tennessee territory.

John W. Freeman, for some time connected with the Sprague Electric Company, has recently been appointed manager of its Pittsburg office to succeed F. W. Barry, resigned.

Frank Wells Hall has become manager of the Philadelphia branch of the Sprague Electric Company. Mr. Hall has been with the company for some time, formerly acting in an engineering capacity.

W. M. Ewart, for the past two years instructor and demonstrator of mechanical drawing, McGill University, is now in charge of the drafting room of the Jenkins Brothers, Ltd., Montreal, Can.

Howard S. Riddle, works manager of the Jeffrey Manufacturing Company, Columbus, Ohio, has recently been transferred to the Montreal plant of his company to act in the same capacity of works manager.

Nelson E. Symons, who has been president of the Pioneer Cast Steel Truck Company, Chicago, Ill., has recently joined the organization of the Chicago Great Western railway to act as superintendent of motive power and machinery.

J. E. Johnson, Jr., general manager of the Princess Furnace Company, and an occasional contributor to our columns, has resigned his position, to take effect April 30. Mr. Johnson expects to be engaged for some months on special work.

Robert J. Hearne, secretary and treasurer of the Dubrow & Hearne Manufacturing Company, sailed for Antwerp on April 17, and expects to make a business trip of two months, taking in Germany, Switzerland and England. Mrs. Hearne and daughter will accompany him on the tour.

Thomas D. West, for many years connected with the T. D. West Foundry Company, Sharpesville, Penn., has resigned his position and will associate himself with the West Steel and Iron Casting Company, Cleveland, Ohio, of which his son is president. On the occasion of his leave-taking he was presented with a large loving cup as a token of esteem by his former employees, in addition to being tendered a remarkable farewell reception participated in by all classes of the community.

*Items for this column are solicited.

Forthcoming Meetings

American Society of Mechanical Engineers, semi-annual meeting, Washington, D. C., May 4-7. Calvin W. Rice, secretary, 29 West Thirty-ninth street, New York City.

American Supply and Machinery Manufacturers Association, joint convention with Southern Supply and Machinery Manufacturers Association, Chattanooga, Tenn., May 5, 6, 7; headquarters, Hotel Patten.

National Supply and Machinery Dealers Association and American Supply and Machinery Manufacturers Association, joint convention, Pittsburg, Penn., May 12-13-14, headquarters Fort Pitt hotel. A. T. Anderson, secretary, Wade building, Cleveland, Ohio.

The Foundry and Manufacturers' Supply Association, convention, Cincinnati, Ohio, week of May 17.

American Foundrymen's Association convention, Cincinnati, Ohio, May 18-20, headquarters Hotel Sinton. Richard Moldenke, secretary, Watchung, N. J.

National Machine Tool Builders' Association, spring meeting, May 25-26, Milwaukee, Wis., headquarters, Plankington house. P. E. Montanus, secretary, Springfield, Ohio.

American Hardware Manufacturers Association, joint convention with Northern Hardware Jobbers Association, Pittsburg, Penn., June 9-11, headquarters Hotel Schenley. F. D. Mitchell, secretary, 309 Broadway, New York City.

Railway Master Mechanics Association, annual convention, June 16-18, Atlantic City, N. J. Jos. W. Taylor, secretary, Old Colony building, Chicago, Ill.

Master Car Builders Association, annual convention, June 21-23, Atlantic City, N. J. Jos. W. Taylor, secretary, Old Colony building, Chicago, Ill.

American Society of Testing Materials, annual meeting, June 29, Atlantic City, N. J. Edgar Marburg, secretary, University of Pennsylvania, Philadelphia, Penn.

Business Items

T. G. Vansant and J. E. Brown have organized the Black River Iron Works, Poplar Bluff, Mo., and are equipped to do all kinds of jobbing work.

Ira J. Owen is now located in a new office, 855-56-57 First National Bank building, Chicago, Ill., and will continue in the same line of business, making a specialty of factory engineering.

The Utica Drop Forge and Tool Company will, from April 1, 1909, sell their own product direct to the trade. All correspondence should be addressed to the general office, 890 Whitesboro street, Utica, N. Y.

The Independent Pneumatic Tool Company, of Chicago, Ill., has appointed the Burnite Machinery Co., 1710 Glenarm street, Denver, Colo., exclusive Colorado agents for its line of "Thor" tools.

Tate, Jones & Co., Inc., have just received an order through the Erie City Iron Works for the Union Pacific Railway at Omaha, Neb., for complete oil burning equipment for use in connection with the Erie City "Economic" boilers.

Edwin C. Thurston, formerly with the Gould & Eberhardt Co., and J. C. Blair, expert toolmaker, machine builder and manufacturer of metal specialties, have established a business at 78 Clinton street, Newark, N. J., where they will conduct a general designing and experimental machine shop.

Business Opportunities

The Buffalo (N. Y.) Box Factory will enlarge plant.

The National Lock Company, Rockford, Ill., will erect a new plant.

The Hagerstown (Md.) Silk Company will erect a four-story addition to mill.

Jansen & Pretzfeld, Newark, N. J., will build another silk mill at Lebanon, Penn.

The Union Drop Forge Company, Chicago, Ill., is preparing plans for a new plant.

The American Metal Door Company, Jamestown, N. Y., will build a new factory.

The Michigan Central Railroad Company is to build a new roundhouse at Jackson.

The Independent Die Company, St. Louis, Mo., is building a new one-story factory.

The Salt Lake Safe and Lock Company, Salt Lake City, Utah, is erecting a new plant.

The Overland Automoblie Company, Indianapolis, Ind., is planning to erect a new and larger plant.

The plant of the Bryant Lumber Company, at Fourche, Ark., was destroyed by fire. Loss, about $75,000.

Fire destroyed the plant of the Trotwood (Ohio) Canning Company, entailing a loss of about $11,000.

The planing and sawmill of Hallack & Howard, Denver, Colo., was damaged by fire to an extent of about $150,000.

The plant of the Nicholas & Longworthy Machine Co., Hope Valley, R. I., was burned. Loss, about $100,000.

The Frontier Iron Works, Buffalo, N. Y., has let contract for construction of its new foundry and machine shop.

The O. H. Jones Company, Hartford, Conn., manufacturing plumbers' specialties, is establishing a brass foundry.

The Great Lakes Engineering Company, of Detroit, Mich., is to build a big shipbuilding plant at Ashtabula, Ohio.

The Vulcan Detinning Company, 157 Cedar street, New York, will rebuild foundry at Seawarren, N. J., recently burned.

The plant of the Faribault (Minn.) Gas Engine Manufacturing Company was destroyed by fire, causing a loss of about $10,000.

The Remington & Sherman Co., Philadelphia, Penn., manufacturing safes, is having plans prepared for a new factory building.

August Griffoul, Newark, N. J., is having a building erected at 280-282 Chestnut street to be occupied by him as a silver foundry.

The Acme Machinery Company, Cleveland, Ohio, is having plans prepared for an addition to plant. This is to be about five or six stories.

It is said the Republic Iron and Steel Company of Pittsburg, Penn., has decided to go ahead with the plan of building a tube mill at Youngstown.

Plans are now being made for the new manual training school in Newark, N. J., by George W. Knight, supervising engineer of the Board of Education.

Bids will be received until May 11 by John H. Landis, superintendent U. S. Mint, Philadelphia, for supplies for use during fiscal year beginning July 1.

The repair shop and barn of the Interborough Rapid Transit Company, at 128th street and Third avenue, New York, were almost completely destroyed by fire.

The York Manufacturing Company, York, Penn., building refrigerating machinery, has made plans for additions to plant. About $300,000 will be expended.

The Mackenzie-Walton Company, of Providence, R. I., is planning to build a factory in Pawtucket for the manufacture of seamless wire tubing for automobiles, etc.

The Rock Island (Ill.) Sash and Door Works is having plans prepared for two new factory buildings, one to be used as a veneer door factory and the other as a planing mill.

The Corry (Penn.) Caster and Manufacturing Company is erecting a plant for the manufacture of casters and small metallic novelties. Would like catalogs of machinery suitable for this purpose.

The American Laundry Machinery Company, Rochester, N. Y., is planning to erect a new plant at Gates, a suburb of Rochester. This will cost about $400,000 and will take the place of the several plants now being operated in different cities.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: April 13—Chain and triplex blocks, pneumatic drills, pneumatic hammers (schedule 1082); induction motors (schedule 1095); wire (schedule 1077); surface bench grinder, taps and dies (schedule 1094); reamers, steel measuring tape, bench vises (schedule 1096); high speed tool steel (schedule 1079); cocks, valves, pipe (schedule 1083, 1086, 1094). April 20—Furnishing and erecting crane (schedule 1101); toolmakers' lathe, turret, lathe, miller, shaper (schedule 1100); turbo-generating sets (schedule 1099). April 27—Calipers, copper rivets, etc. (schedule 1092); May 4—Traveling crane (schedule 1104).

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: April 27—Tube expanders, feed pumps, steel tubes (schedule 1147); copper, brass tubing (schedule 1146); electric heaters (schedule 1140); bolts and nuts, chucks and dies, hinges, tools, locks (schedule 1143); machinery and bar steel (schedule 1144); high speed steel (schedule 1142). May 4—Leather belting (schedule 1166); centrifugal pump (schedule 1157); depth recorders (schedule 1161); bolts and nuts (schedule 1159); dies, emery wheels (schedule 1162); steam capstan (schedule 1155); grinding machine (schedule 1151); bevel gear planer (schedule 1154); reamers and cutters (schedule 1162); shaper (schedule 1150); steel angles, steel bars, bar iron, steel plates (schedule 1164). May 18—Hoisting crane (schedule 1156); belt fixers' bench (schedule 1152).

New Incorporations

The Wood & Spencer Co., Cleveland, Ohio, has been incorporated to manufacture special machine tools and to do a general machine business.

The Cartridge Coil Company, Lafayette, Ind., has been incorporated to manufacture electrical appliances. Capital, $50,000. Incorporators, H. D. Stroud, W. H. Conners, W. E. Doolittle.

The Haselton Steel Tube Company, Jersey City, N. J., has been incorporated to manufacture iron and steel pipe, etc. Capital, $200,000. Incorporators, R. A. Mackey, J. A. Laing, H. M. Durning, etc.

The Albany Car Wheel Company, Albany, N. Y., has been incorporated with $100,000 capital to manufacture car wheels. Herman F. Ball, 30 Church street, Albany, is one of the incorporators.

Perfect Keyless Lock Company, New York, has been incorporated to manufacture locks, fastenings and attachments. Capital, $500,000. Incorporators, O. M. Farrand, J. P. Conkling, T. Conyngton.

The General Heater Company, Cleveland, Ohio, has been incorporated with $125,000 capital to manufacture steam and hot water heaters. Incorporators, E. A. Halbleid, J. C. Halbleid, C. A. Niman, etc.

The Kenney Manufacturing Company, New London, Conn., has been incorporated to manufacture and deal in engines and machinery. Capital, $50,000. Incorporators, Frank S. Joseph, H. H. Smith, etc.

The Bryant Chucking Grinder Company, Springfield, Vt., has been incorporated with $120,000 capital to manufacture and sell machinery, tools, etc. Incorporators, W. L. Bryant, W. D. Woolson, Jas. Hartness.

The Dixon Cable System, Jersey City, N. J. has been incorporated to manufacture electrical or other contrivances for telephones or telegraph. Capital, $300,000. Incorporators, H. O. Coughlan, B. S. Hantz, J. B. Turner.

H. Bartholomew & Co., Camden, N. J., has incorporated with $50,000 capital to manufacture iron and steel. Incorporators, H. Bartholomew and H. H. Farley, Betz building, Philadelphia, Penn.; J. C. Haines, 301 Market street, Camden.

The Elgin-Sycamore Railway Company, 69 Dearborn street, Chicago, Ill., has been incorporated to construct and operate a railway from Elgin to Dixon, Ill. Capital, $100,000. Incorporators, Bruce C. Payne, E. S. Bailey, F. W. Merrick.

The Union Draft Gear Company, Chicago, Ill., has been incorporated with $2,000,000 capital to manufacture and deal in railway specialties, equipment and appliances. Incorporators, M. J. O'Brien, D. L. Madden, Francis O'Shaughnessy.

The Hobart-Allfree Company, New London, Conn., has filed certificate of incorporation. Capital, $50,000. Incorporators, B. F. Hobart, New York; Jas. B. Allfree, Chicago; M. F. Rafferty, New London. Will manufacture engines and locomotives.

The Gould Specialties Corporation, New York, has been incorporated to manufacture machinery, engines and mechanical devices. Capital, $60,000. Incorporators, R. M. Stephens, Hackettstown, N. J.; T. A. Gould, Newark, N. J.; J. B. Wentworth, New York.

The Turner Baffle-Wall and Boiler Company, Brooklyn, N. Y., has been incorporated to manufacture baffle walls, baffle plates, boilers, etc. Capital, $20,000. Incorporators, P. S. Riggs, 176 Broadway, and Roy Murchie, 130 Broadway, New York; R. A. Wright, Brooklyn.

Trade Catalogs

S. Obermayer Company, Cincinnati, O. No. 3 historical picture post card, depicting first castings on record.

The H. D. Smith & Co., Plantsville, Conn. Folder illustrating and describing "Perfect Handle" screw driver.

Quick Automatic Vise Company, 236 Mill street, Rochester, N. Y. Circular illustrating and describing Rochester vise.

Williams Foundry and Machine Company, Akron, Ohio. Booklet describing Akron clutch. Illustrated, 26 pages, 3½x6 inches.

J. S. Bretz Company, Times building, New York. Catalog of F. & S. ball bearings. Illustrated, 116 pages, 6x9 inches, paper.

Niles-Bement-Pond Company, 111 Broadway, New York. Catalog of Bement hammers. Illustrated, 52 pages, 9x12 inches, paper.

The Manville Bros. Co., 23-33 Benedict street, Waterbury, Conn. Catalog of foot presses. Illustrated, 20 pages, 5x7½ inches, paper.

The Field-Brundage Company, Jackson, Mich. Catalog describing Field gas, gasolene and distillate engines. Illustrated, 24 pages, 7x9 inches, paper.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith, Columbia, Penn.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

We manufacture on royalty or buy outright patents on small tools. Box 104, AMER. MACH.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

A large foundry and machine shop desires to add to present lines of manufacture. Box 126, AMERICAN MACHINIST.

Machines designed; automatic, special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Wanted—Punch press and jig work; good facilities for manufacturing of light articles. Models, dies, tools, etc., made. Joseph Pollak, 215 Sydney St., Dorchester-Boston.

Mechanical engineer will shortly visit Europe on business and will make special investigations or transact business for interested parties. Have wide acquaintance here and there. Box 125, AMERICAN MACHINIST.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Morgan Spring Company, Worcester, Mass., is desirous of getting into touch with manufacturers of machinery who are able to supply an automatic machine to take wire in coil and drop out a small size corkscrew made entirely from wire. Box 127, AMER. MACH.

Wanted—A thorough business man with $5000 or $6000 to engage in the manufacturing of a new chuck, which is in great demand for machine shops. It has the widest range of any chuck of its kind ever put on the market. To the right party will give half interest to patent. A good opportunity for a good business man. No other need apply. Box 119, AMERICAN MACHINIST.

Proposals for Ordnance Supplies—Watervliet Arsenal, Watervliet, N. Y., April 17, 1909. Sealed proposals, in triplicate, will be received until 1 p.m., **May 17, 1909, for furnishing iron, steel, hardware, forage, fuel, oils, etc., during year ending June 30, 1910.** Information furnished on application. Lt. Col. W. W. Gibson, Comdg.

Situations Wanted

Classification . indicates present address of advertiser, nothing else.

CONNECTICUT

Good superintendency wanted by live producer. Now employed. Box 116, AMER. MACH.

Would like to correspond with reliable company desiring to secure the services of a first-class mechanic as assistant superintendent or general foreman. Box 149, AM. M.

MASSACHUSETTS

Wanted—Position by production man of eight years' experience in large machine shop; fully acquainted with office detail, stock and piece work systems; age 34. Box 145, AM. M.

Englishman, 26, married, alert and ambitious, seeks post as tool designer or assistant superintendent. Good mathematician and practical mechanic. Executive ability. Enterprising firm preferred. Box 103, AMER. MACH.

Wanted—Position as chief draftsman with small firm or assistant to chief with large firm, manufacturing medium weight machine tools or other machinery. Good designer with executive ability. Age 30. Box 86, AM. MA.

Chief draftsman; technical graduate, both mechanical and electrical engineering; four years' shop and drafting room experience with General Electric Company, 4 years' designing motors and steam engines; desires a position as designer or assistant engineer. Box 147, AMERICAN MACHINIST.

MICHIGAN

Situation Wanted—As superintendent or shop manager; 20 years' experience manufacturing small interchangeable parts. Thoroughly understand shop organization, cost systems, etc. Can produce the maximum at the minimum cost. Am an expert on all kinds of piece work. Am 38 years of age and married. At present employed, but desire to make a change; good reasons given. Can furnish best of references. Will go anywhere if salary is right. Box 48, AMERICAN MACHINIST.

NEW JERSEY

Mechanical draftsman wishes to change. Address Box 152, AMERICAN MACHINIST.

Automobile repair and contract machinist, married, 26 years old, several years foreman, desires position. Box 137, AMERICAN MACH.

A mechanical electrical engineer with an established reputation in large manufacturing and power plants and in all kinds of power development, would accept a position with a reliable concern; at present in good position, but desire change; can furnish very best references. Address "W. H. S.," AMER. MACH.

NEW YORK

Chief draftsman, long experience in pumping machinery, air compressor, condensers. New York City. Box 140, AMERICAN MACHINIST.

Position as inventor, designer, draftsman or toolmaker, mica insulation dies, molds and fixtures a specialty. 18 years' experience. Box 128, AMERICAN MACHINIST.

Wanted—Position as draftsman with a concern having an opening for a beginner with technical education; best of reference. Box 150, AMERICAN MACHINIST.

Designing draftsman on steam pumping machinery; seven years' drafting room, and five years' shop experience. Technical education; desirous of changing position. Box 146, AMERICAN MACHINIST.

A competent man 35 years of age, with 15 years' experience in machinery and supply trade in New York, desires position with manufacturer or merchant as salesman or purchasing agent. Address "Vigilantia," Box 53, AMERICAN MACHINIST.

Mechanical, structural, marine draftsman, computer; technically educated, familiar with Manheim's, Fuller's, Tacher's slide rules planimeter, intergrator, interchangeable, automatic typewriter machine, torpedoes, submarine boats, power presses; wishes good offering. Chief draftsman preferred. Box 133, AMER. MACH.

Factory manager, American, technical, experienced. At present employed, desires to change. Thoroughly acquainted with manufacturing, maintenance of plant, management and production. Expert in handling men. Age 36. Highest references. Address Box 134, AMERICAN MACHINIST.

OHIO

Mechanical draftsman; experienced principally on machine tools; technical, shop man, now employed. Box 136, AMERICAN MACHINIST

Reliable references will inform you that I am a very practical, profitable executive in mechanical manufacture. Please get me busy. Box 135, AMERICAN MACHINIST.

An assistant superintendent, experienced in factory system and handling help; a producer and a technical graduate, desires change. Box 141, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT.

Engineer wanted by a large manufacturing concern building automobile and marine motors. Must have had several years' experience in designing automobile and marine gasolene motors. None but the best need apply. Good permanent position to right man. Give references, experience and salary wanted. "Engineer," Box 124, AMERICAN MACHINIST.

Wanted—By large machinery manufacturing concern, chief inspector. Must be first-class mechanic, experienced on gasolene motor work. Capable of organizing and directing corps of inspectors. Good permanent position to right man. Give references, experience and salary wanted. "Chief Inspector," Box 123, AM. MA.

Wanted—By a large manufacturing company, general superintendent, to take charge of a factory making gasolene automobile motors and other high class machinery products. Must be a good producer and a hustler. None but the best need apply. Good permanent position to the right man. Give references, experience and salary wanted. "General Superintendent," Box 120, AMERICAN MACHINIST.

ILLINOIS

Wanted—First-class draftsman with experience designing four-valve Corliss and non-releasing valve gear engines. Box 129, AM. MA.

INDIANA

Wanted—A-1 man for foreman drop forge department of 10 board and steam hammers. State experience, salary expected, reference. Address "Manufacturers," care AMER. MACH.

Wanted—Large automobile manufacturers want general foreman for machine shop employing 500 men. State experience, salary, reference, etc. Address "Automobile," care AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—Practical gear cutting expert on all classes of gear work. State age, experience and wages expected. Boston Gear Works Norfolk Downs, Mass.

Wanted—Experienced operator on bevel gears to run Gleason machines. State age and give references. Boston Gear Works, Norfolk Downs, Mass.

Wanted—An assistant to superintendent and general manager in a large gear jobbing shop. Must be experienced in mechanical work, technical and practical; also up-to-date on modern methods. State age, experience and salary expected. Boston Gear Works, Norfolk Downs, Mass.

Wanted—A first-class designing engineer capable of designing special printing machinery and who can assume the responsibility of improving and perfecting machines now in construction; must have a knowledge of economical manufacturing methods. Box 144, AMERICAN MACHINIST.

Wanted—A designing engineer familiar with modern high and medium speed steam engine practice; must be able to show a satisfactory experience and refer to a successful practice on not less than three years with a standard concern. A knowledge of economical manufacturing methods for quantity production desired. Box 102, AMERICAN MACHINIST.

Wanted—A general foreman familiar with modern practice in high and medium speed engine construction; must know how to get best efficiency from up-to-date tools and equipment. Only such applicants will be considered as can show an executive experience of not less than three years with an up-to-date manufacturing company. Familiarity with modern factory systems necessary. Box 101, AM. MACH.

MICHIGAN

Wanted—Foreman toolmaker who understands designing and making of drawing and stamping dies for medium size work. Tools for monitor and automatic screw machines. In applying give age, experience, references and salary wanted. Address P. O. Box 643, Detroit, Mich.

NEBRASKA

Wanted—Foreman to take charge of a marine gas engine factory. Must have an experienced man capable of handling good men and producing high class work. Box 139, AMER. MACH.

NEW JERSEY

Wanted—Two competent draftsmen for printing press work. State age, experience, references and salary. Box 138, AMER. MACH.

Wanted—Hammersman; must be skilled on heavy forgings; steady work for a reliable and sober man. Address, stating experience and wages expected, "E. L. S.," AM. MACH.

NEW YORK

Wanted—Steel salesman. One able to demonstrate high speed tool steel and with shop experience. Apply with references and salary. Box 97, AMERICAN MACHINIST.

Wanted—Competent man with experience as speed boss and thoroughly familiar with premium system. Apply, stating age, experience, salary desired. Box 105, AMER. MACH.

Wanted—A thorough up-to-date man accustomeed to tool stores departments and systems for plant of 1000 employees. Apply, stating age, education, salary expected. Box 106, AMERICAN MACHINIST.

Wanted—Draftsman on small work, similar to counting and indicating instruments, who can develop from sketch. Give full particulars. Address "Invention," Box 148, AMERICAN MACHINIST.

Wanted—First-class salesman, must have established trade among steam users in engineers' and factory supplies in Greater New York and vicinity. Fine position for right man. Box 131, AMERICAN MACHINIST.

Wanted—By manufacturer, thoroughly experienced man to sell hangers, shafting and transmission machinery in New York City and vicinity. Must be capable, energetic. We want the best man in this line of business. Box 130, AMERICAN MACHINIST.

Wanted—A few experienced mechanical draftsmen with experience in steam engines, piping, furnaces, structural steel, etc., for work in country in Western New York. Give fullest particulars and state salary required. Address John Primrose, Dansville, New York.

Wanted—Shop superintendent, practical, experienced, modern shop methods required, steady position, fast growing business. Address, stating qualifications, experience and wages desired. None but first-class men need reply. Kerr Turbine Co., Wellsville, N. Y.

OHIO

Wanted—Chemist at once. Write, giving experience, salary and reference. Steady employment for the right man. Box 151, AM. M.

Wanted—Three good erectors familiar with medium, light or heavy gas engine work. Also lathe, planer and boring mill men. Can use two good toolmakers. Address Box 132, AM. MA.

Wanted—Salesman for highest grade electric drills and grinders. Best commissions and permanent arrangements for territory made with right parties. Address the Cincinnati Electrical Co., Cincinnati, Ohio.

I am the superintendent of one of the largest machine tool concerns in the United States and want a young man who can grow up in our establishment and finally take my position. This man need and preferably should not be over 30 years old. Must have had a varied and practical experience on engineering matters outside of the machine tool lines. Must speak English and some German. Should have a university or college education, executive ability and a good address. If you're the man I'm looking for write, "Supt.," Box 143, AMER. MACHINIST.

PENNSYLVANIA

Wanted—Two machinists experienced erecting high-speed steam engines in shop and on road. Give details of past experience and wages. Box 42, AMERICAN MACHINIST.

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The Automatic Manufacture of Steel Rails

A Description of the Manufacture of One of Our Most Useful Products, Involving Employment of Automatic Machinery of the Heaviest Class

EDITORIAL CORRESPONDENCE

A hundred thousand tons—five hundred thousand tons of steel rails! Every now and then we see newspaper notes of such orders being placed by the big railroad systems with the steel mills of this country.

Did you ever stop to figure how long a track can be built with 100,000 tons of rails? At 90 pounds to the yard, as an average, 100,000 tons of rails would make a single track over 630 miles long. Five hundred thousand tons would reach almost from New York to San Francisco, not laid end to end, but counting on two continuous rails laid side by side, to form a track.

Another question: While riding along in a railroad car, listening to the wheels striking the rail joints, has it ever occurred to you that in the making of all these miles upon miles of rails, although the great steel mills number their men in the tens of thousands, hardly a human hand has touched these rails from the time the iron ore was dug from the earth until the finished steel rail was loaded upon a flat car for shipment to its appointed place of service?

The rail mills never rest. Some part of them is working 365 days in the year. At night the glow from their furnaces and the fountains of sparks from the converters reflect on the smoke and steam that roll up in many-colored clouds, while for miles back in the country can be heard the booming sound of the gears of the 2000-horsepower rolling engines, as they reverse again and again.

Long trains of steel, hopper-bottom cars bring the iron ore to the mills. These shipments of ore look like loads of reddish brown earth, and one wonders how it was ever discovered that this worthless looking stuff could be turned into iron and steel for useful purposes.

When the trains come in, the cars are run, one at a time, up onto a large, steel, tower-like structure. At a signal the steel car with its 100,000 pounds of ore, begins to rise and turn over at the same time. It goes slowly upward, and turns farther and farther, but it cannot fall out because it is held to the rising track by heavy arms. When the car has been raised to a considerable hight it is practically upside down, and presents a wierd sight from the ground. The load of ore drops out, and sliding down a steel apron, falls into another car below, which belongs to the steel company, thus releasing the car of the railroad company very shortly after it is delivered. The upraised car comes gradually down again, and finally runs off down an incline to join the long lines of empties to go back to the mines, or the lake steamers.

The ore is taken in the steel company's car to the "orefields," which are broad storage yards. Here it is dumped from the bottoms of the cars into piles of selected kinds of ore, and from here again it is picked up by electric traveling cranes of 300 feet span and 1000 feet travel, and finally distributed into ore pockets or bins, according to its kind and quality.

FIG. 1. ORE BRIDGES OF THE LACKAWANNA STEEL COMPANY AT BUFFALO

These bins have steel doors, not unlike the mouth of an old-fashioned powder horn, many times magnified. Under these doors, or mouths, there dart in and out dozens of little electric cars that combine in their make-up the propelling motors, a steel hopper poised on a scale beam, and a recording mechanism for registering the weight of its load. These little cars stop at different bins and sort out one kind of ore here, another there; a load of coke here, and a load of limestone there. The weights of the various ingredients are all automatically registered and in the right proportion, the loads are dumped into the "skip hoists" of the row of blast furnaces.

blowing engines. From other brick-lined pipes at the top there issue more millions of cubic feet of all-but red-hot gases. These gases are inflammable, and are led to tall, brick-lined towers called "hot stoves," where they are burned to heat the air from the engines. The gas is also burned under boilers and used in gas engines for the generation of steam and power.

The furnaces themselves look like round towers, having a relatively large diameter. The largest ones are about 100 feet high and probably 30 feet in diameter near the middle, being smaller at top and bottom. About once in three hours the

out its fiery contents into one of a row of large receptacles, each of which holds a veritable lake of molten iron.

At intervals, by the operation of a valve these receptacles tilt out their contents into another ladle car which travels automatically back and forth, supplying a row of several bessemer-steel converters.

These converters are like large steel eggs set up on end, and supported on trunions or bearings, placed at their widest part. They are about 15 feet in diameter by probably 20 feet high. They are lined with firebrick and clay, are open in a narrow mouth at the top, while at the bottom there are "tuyeres," or openings

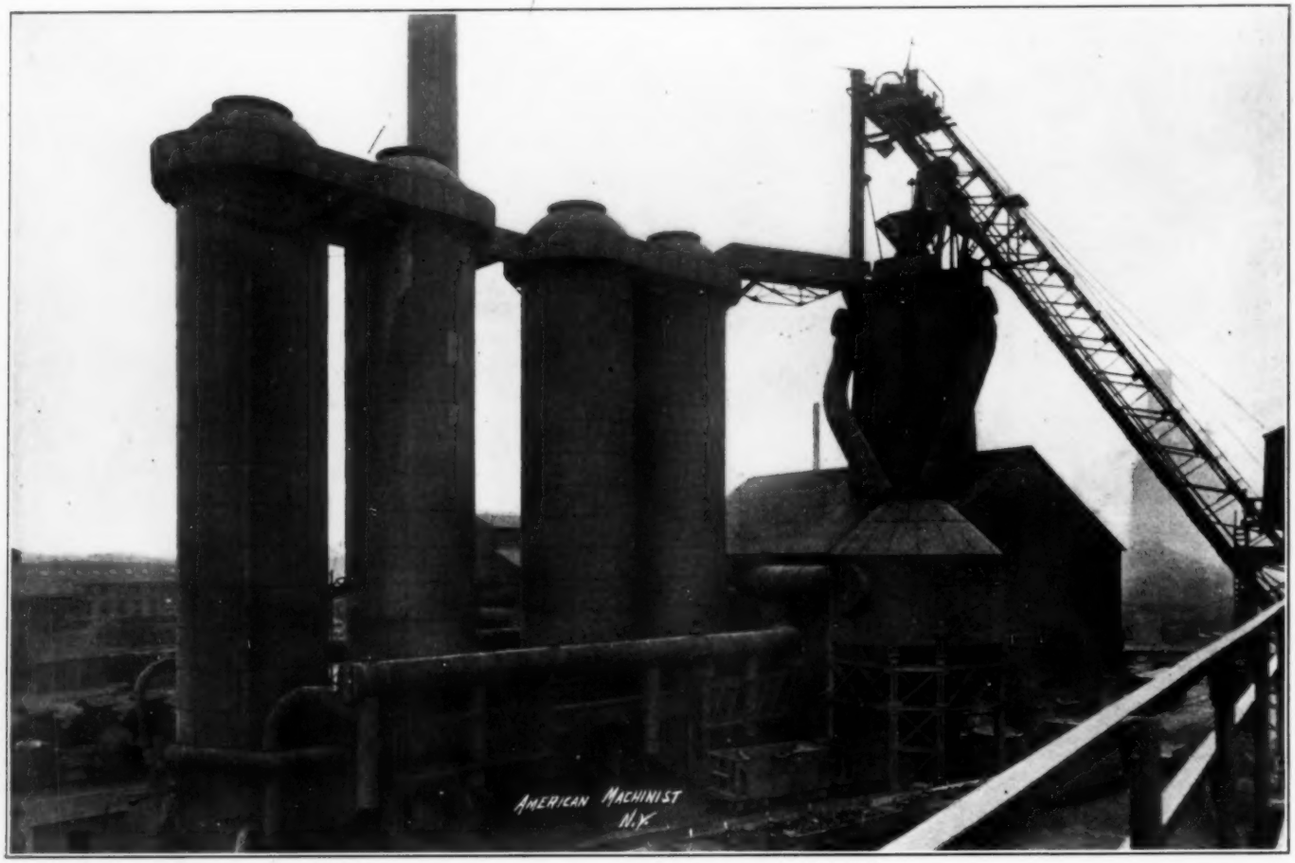


FIG. 2. BLAST FURNACE AND HOT STOVES, LACKAWANNA STEEL COMPANY

The skip hoists dart up the inclined tracks leading to the tops of the furnaces, where they automatically turn bottom up and drop their contents into the receiving "bell" or hopper. By the motion of a hydraulic valve at the base of the furnace, the bell closes to keep the gases in, and another opens below it and drops the ore, coke and limestone down into the furnace itself.

Within, the furnace is a mass of burning coke and melting limestone and iron. At the bottom great brick-lined steel pipes are delivering millions of cubic feet of air previously heated to about 900 degrees temperature, at from 10 to 20 pounds pressure, from thousands of horsepower of

smelting process is sufficiently advanced to allow of the drawing off, or "casting," of the molten iron formed from the ore, which was put into the furnace, along with the coke and limestone. In what is known as the "hot-metal process," this molten iron is run off into "hot metal" cars. These are large iron ladles, lined with fireclay and mounted on car wheels. Trains of this molten iron are taken to the "bessemer houses," where an elevator lifts one car at a time, wheels and all, up to about the fourth floor. Here an automatic pouring device advances, thrusts out an arm, and gripping hold of a screw shaft on the car, turns the shaft, causing the ladle to slowly tip, pouring

through which air is blown. The air comes from other blowing engines and passes to the converter through the trunnions on the sides and being led by a duct, enters the interior through the tuyeres in the bottom from which it bubbles up through the molten iron, causing a combustion of the fiercest intensity.

In the converter room no man is seen to handle the converters, or cranes, or ladles. All the operations are controlled by hydraulic valves turned by half a dozen men in a protected gallery known as the "pulpit." By these valves the converters are tipped back, the molten iron poured in, the compressed air turned on, the converter stood upright, and from its mouth

there issues a fountain of flame and sparks that beggars description, and which casts its light for miles on the darkest night. The bubbling of the air through the molten cast iron causes the burning out of the various foreign ingredients. The greatest of these is carbon, while silicon and some sulphur are also burned. There are also small quantities of other substances in the iron which burn with literally all colors of the rainbow. One can stand for hours at night watching the magnificent spectacle of a row of these bessemer converters which rival any artificially colored fireworks ever devised.

The flame continues and the colors change and begin to lose their variegations, approaching a white of unequaled brilliancy. When the proper color has been detected by the practiced eye of the bessemer expert the valve is thrown, the converter tips slowly forward, the compressed air is gradually shut off, and the flame ceases, with the converter almost on its side.

Now there comes a smaller ladle carried on the arm of a hydraulic crane, not touched by hand but controlled from the pulpit. In this ladle is melted "spiegeleisen," a variety of cast iron containing just the right percentage of carbon and manganese which, when poured into the converter now containing what is practically molten wrought or pure iron at fiercest heat, creates a compound mixture known as bessemer steel. This is what rails are made of, and this is the cheapest method of making steel. To make it requires a special grade of iron ore, especially low in phosphorus content, as the phosphorus cannot be effectively removed by this bessemer process. Bessemer steel is not as good as open-hearth steel, which is more expensive, and which is made by long continued melting of a mixture of various grades of iron and scrap steel in reverberatory furnaces.

The liquid bessemer steel is poured out by further manipulation of the hydraulic valves into ladles on automatic cranes, lifted up and again poured into rows of tall cast-iron ingot molds resting on odd little cast-iron, narrow-gage cars. The molds are about 10 feet high and about 2 feet square inside, tapering slightly toward the top. A small locomotive draws a train of six or eight of these cars, two molds on a car, out into the cooling yards to solidify. In the process of becoming solid, the cast-iron molds become red hot, and they stand in long rows waiting their turn to be "stripped."

Stripping is the removal of the mold from the now solidified steel ingot. To do this the cars are run under a tower where, without apparent human control, a heavy steel finger passes down into the opening in the top of the mold, and two iron hands grip the mold and pull it up, while the finger pushes down on the ingot inside. The mold comes off leaving the still red-hot ingot on the car.

When a whole train of ingots has been stripped the little locomotive rushes it up an incline into the "blooming mill." Here, again, not a soul seems to be touching anything, and yet everything is in rapid motion.

Every now and then, in the semi-darkness of the mill house the floor parts at one's feet, giving out a shriveling heat and a blinding light. This is caused by the moving back of the covers over the "soaking pits"—a series of long, gas-fired heating furnaces under the floor. The covers are large, firebrick blocks mounted on flanged wheels running on tracks, and are operated by hydraulic power controlled from a central point. Below, in the pit, the red and yellow and blue flames are curling, and overhead comes the electric crane equipped with another one of those great iron hands. In its grip is one of the new steel ingots recently stripped of its mold. The hand and ingot approach, turn around, and descend into the mouth of the pit. The hand releases and rising up, leaves its burden below. The cover blocks move back over the flames, and the ingot is left to "soak," or become evenly heated throughout, preparatory to being rolled into a "bloom," or large billet about 10 inches square and several times its former length.

It is here, in the blooming mill, that we

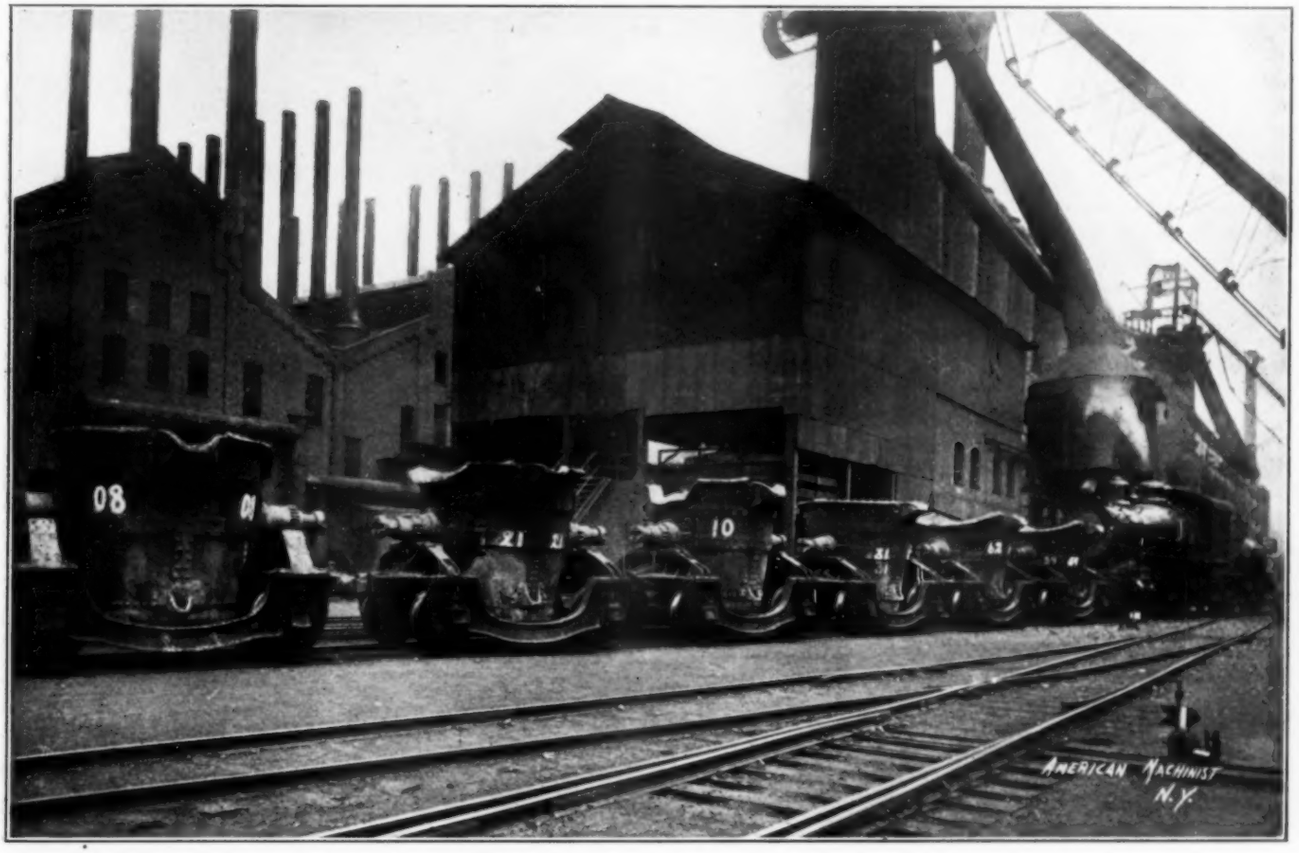


FIG. 3. "HOT METAL" TRAIN CARRYING MOLTEN CAST IRON, LACKAWANNA PLANT

find the source of the booming sound that carries so far out into the country. The main blooming engine makes a dozen rushing turns in one direction and then with a sudden stop and the clanging of its great gear wheels, it reverses its direction of rotation to pass the now thoroughly heated ingot back and forth through the rolls. The electric crane delivers the white-hot ingot to the feeding rollers, which are turned by power, and by their motion carry the ingot up to the mouth of the blooming rolls. At first these blooming rolls are wide apart, one above the other, so as to admit the large ingot, but as its width is reduced, and its length becomes greater, a pair of small engines overhead intermittently give a few rapid turns to the adjusting screws that bring the rolls closer and closer together.

The handling of the heavy ingot during its conversion into a bloom, like all the other processes, is without the direct touch of the human hand. Blindingly hot it is forced through the rolls and out on the other side. A steel finger rises out of the runway, the ingot lifts up and turns over on its side. Another rush is made back through the reversed rolls. It stops. Another steel finger lifts and turns the ingot again. The adjusting engines draw the rolls nearer together; the feeding train reverses, and back the ingot goes again through the rolls. Back and forth it passes, fine streams of water spraying the rolls to keep the metal from sticking, and each pass is heralded by a heavy explosion of steam from the water confined between the rolls and the hot steel, while showers of sparks, the arrival of newly heated ingots, the opening and closing of the pits of fire below the floor, transform the semi-darkness into spots and streaks and showers of brilliant light.

When the ingot has been rolled down to a bloom about 10 inches square, it is carried forward to the trimming shears to have the rough and imperfect ends cropped off. The end of the bloom, still red hot, projects through an opening in a massive shear. By the turn of another valve a heavy knife comes down, and the end of the bloom is literally pushed by a transverse motion (not cut) from the body of the bloom. From the shear the bloom is taken by a conveyer to the rail mill.

At the rail mill is the most wierdly human of all the contrivances of these mills. This is a traveling crane which runs back and forth in front of a long row of ovens in which the blooms are once more "reheated" before rolling into rails. This crane advances to the steel bloom newly arrived from the blooming mill, swings around a most astonishingly human forearm which carries on its outer end a large, steel hand with fingers and thumb, resembling a hand in a mitten, with the thumb separate from the other fingers bunched together. A compressed-air piston opens the hand and, reaching down, it grips the bloom, the thumb and fingers squeezing into its red-hot sides. The arm lifts, the crane makes a rapid run along the furnaces until, stopping before one of the many doors, which opens before it, it swings around, advances and thrusts itself into the furnace up to the "elbow." The arm drops, the thumb and fingers relax, the bloom rests on the floor of the furnace, and the arm backs out again. Now, most human of all its actions, the crane runs along its track to a steel tank, and dropping its forearm, plunges its fingers under water to the accompaniment of hissing steam, like a sigh of relief!

After the blooms have been properly reheated the crane removes them from the furnaces, and placing them on a conveyer, they are carried up to the roughing rolls of the rail mill. These rolls differ from the blooming rolls in that the latter are smooth and reverse to pass the ingot back and forth, whereas the rail-mill rolls are grooved to give the shape to the rail, and are often made "three high," so that the bloom passes first between the middle and bottom rolls, and then back between the middle and top ones, while the driving engine continues to turn in the same direction.

The grooves in the rolls are graduated in form and size, and the bloom advances from one groove to the next, becoming slimmer and slimmer, and longer and longer, while it gradually takes on more and more the shape of a rail. The first pass is called the "cogging" pass, and merely puts deep dents in the sides of the bloom. The next pass follows up these dents with a shallow groove, and the next after that, a deeper groove, while the head and base of the rail come more and more plainly into shape.

In order to pass the bloom first under the lower rolls and then back over the upper ones, there are great "tilting tables" on either side of the rolls. These are movable inclined planes which rise and fall at the end nearest the rolls, to pass the rail up and down and back and forth. In the beds of these tilting tables are feeding rollers which turn and reverse at the proper intervals to feed the rail in and out of the rolls. In these tables also are guides and numerous steel fingers which direct the rail from groove to groove in the rolls, and also turn the rail over at certain passes, to bring all its faces in contact with the rolls.

After probably a dozen passes, the rough-finished rail comes out of the last groove of the roughing rolls, and is taken by a conveyer to the finishing rolls, where the process is completed by a few more passes back and forth. Just before the last pass, the rail, which, by the way is then over ninety feet long, is delayed for a few moments to cool off a little, and then sent back for the final pass in a semi-heated condition. This operation,

FIG. 4. BESSEMER STEEL CONVERTER IN OPERATION, LACKAWANNA PLANT

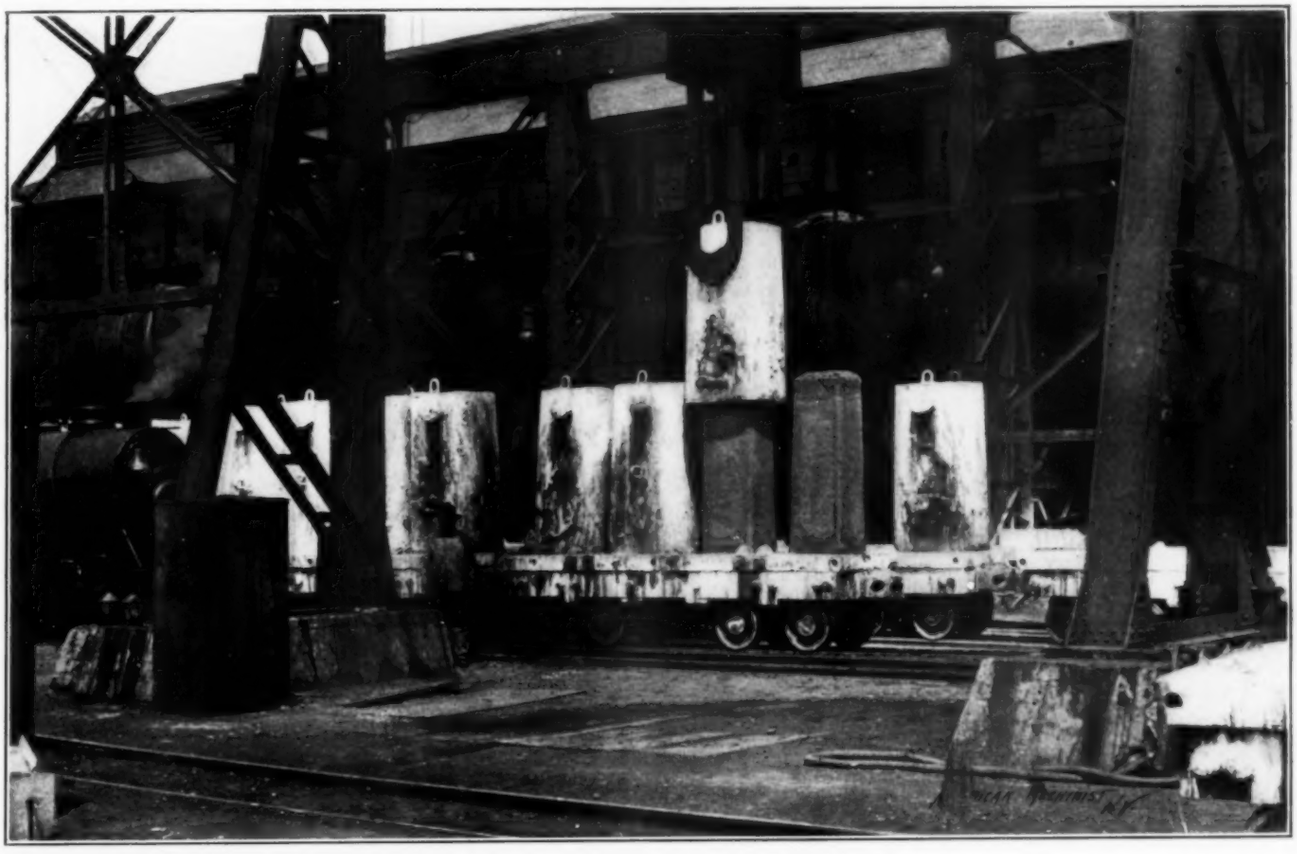


FIG. 5. THE STRIPPER AT WORK, LACKAWANNA STEEL COMPANY

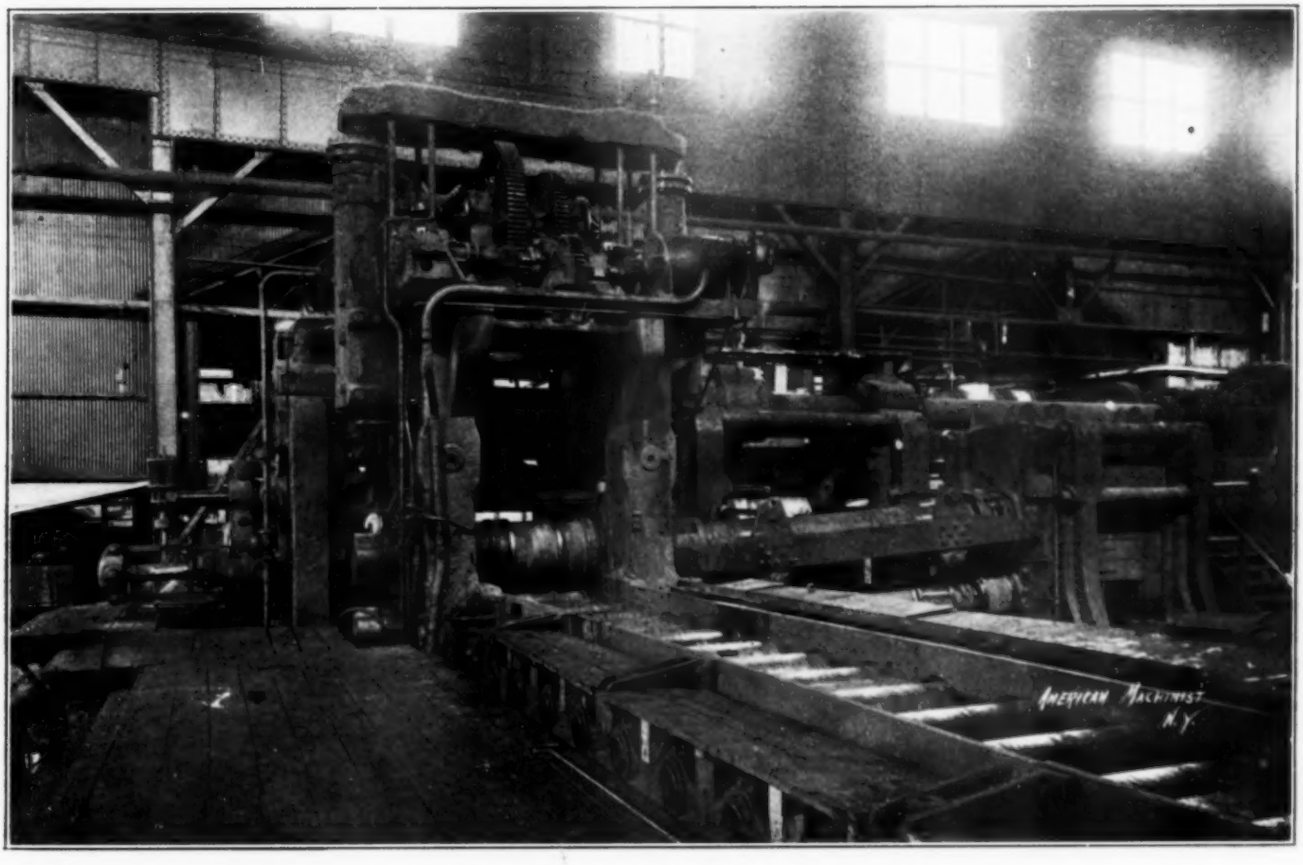


FIG. 6. THE SLABBIN ROLLS, LACKAWANNA STEEL PLANT

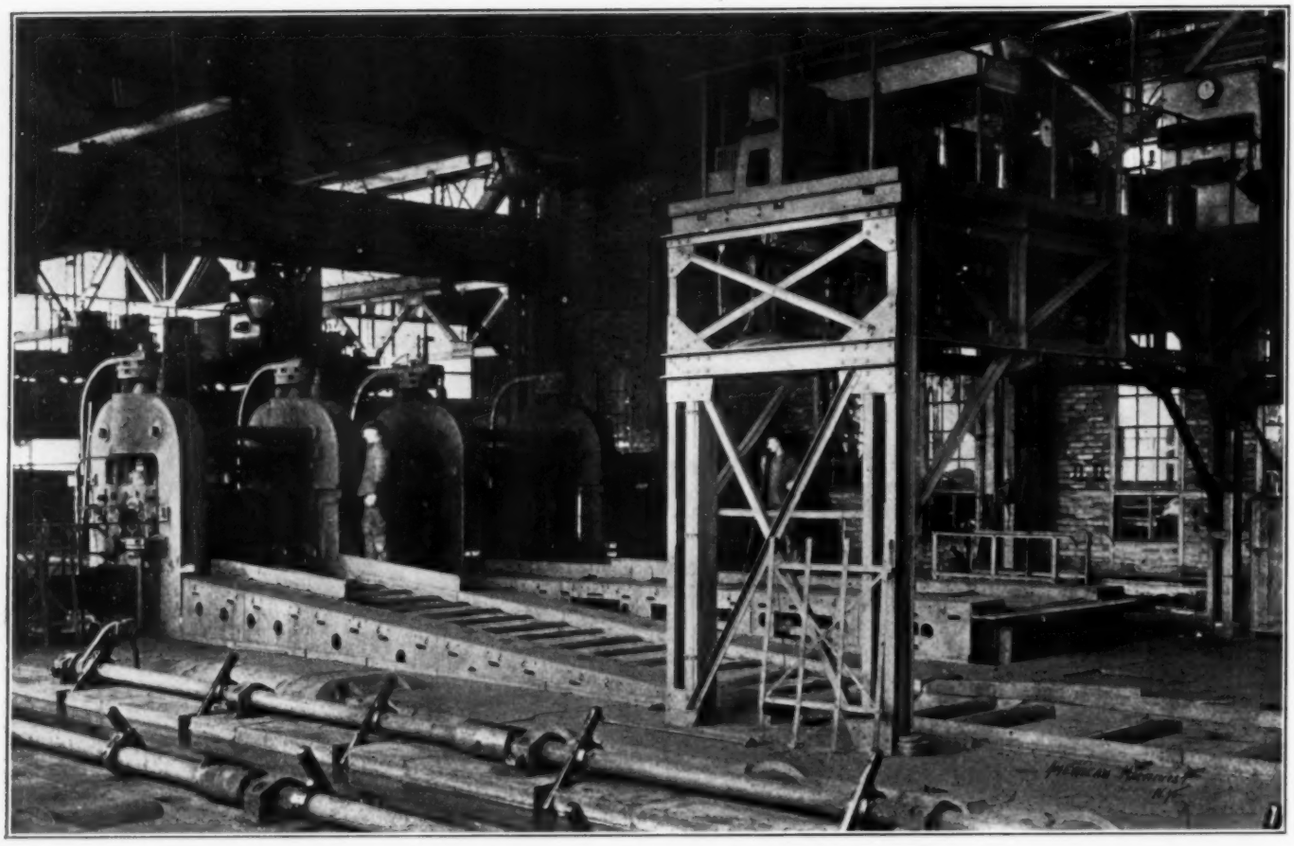


FIG. 7. TILTING TABLES AND PULPIT IN A GERMAN STEEL MILL

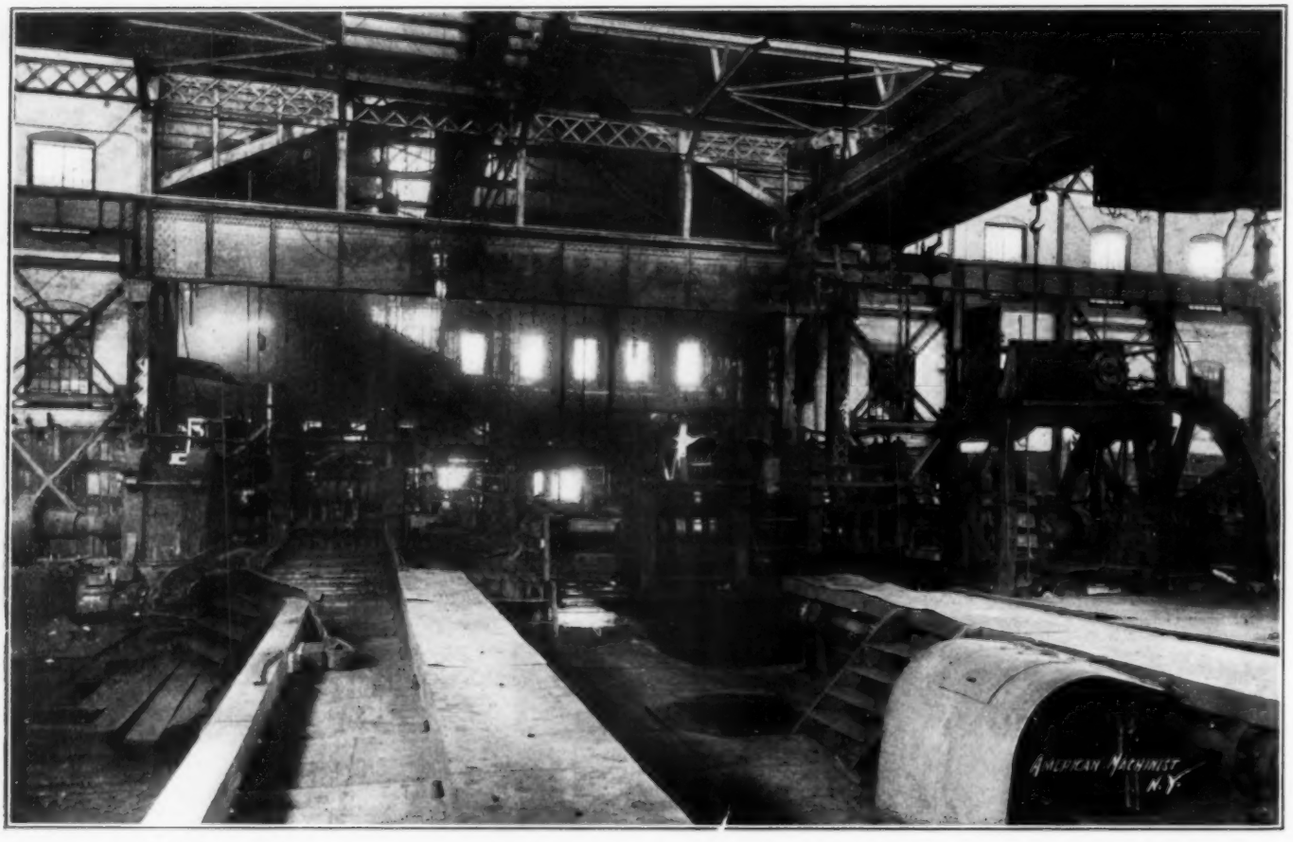


FIG. 8. THE RAIL MILL ROLLS AND RUN WAY, LACKAWANNA PLANT

which is termed "cold rolling" puts a hard finish on the wearing surfaces of the rail and tends to make it wear longer.

After the finishing pass the now only dully red-hot rail is brought by another conveyer to the "hot saws." These are four rapidly revolving circular saws, which at the proper moment advance simultaneously toward the rail, which, with a sharp shriek and showers of sparks is cut into three 30-foot lengths.

After this operation, the three pieces advance in single file, and pass through the curving rolls, where oddly enough, they are deliberately made crooked in order that they may be straight. The fact is that when the rail is cooling, the top and bottom being of different thickness, shrink at different rates, and the rail would curl. The deliberate curving of the still hot rail, in the opposite direction, leaves it practically straight at the finish.

During all this process, no human hand has touched the rail, except perhaps to guide it in case of a slip in the mechanism. Even now a set of fingers advances, propelled by an unseen power, and carries all three section of the rail off to one side to cool on the "hot beds."

The last process is to take out any "kinks" there may be left in the finished rail. This is done by an expert, under a power-driven straightening press, and to his practiced eye the process is the work of but a moment. After this comes the first really manual handling, and this consists in loading the product into flat cars for shipment to purchasers throughout the country.

It was said by old Mr. Fritz, who was the originator of the "automatic three high-rail mill," some years ago, that the day would come when the mills would be started on Monday morning, then the men would go home, and would not return until Saturday night, when their duty would be to weigh the product of the week's operation of the automatic machinery. This stage has not been reached as yet, but the wonderful advances that have been made since that time would lead the seer of today to predict almost anything in the line of automatic machinery.

Even at this time one of the large steel companies in Pennsylvania has an automatic accounting machine for figuring the costs of piece work. It operates by the principle of punched cards, and adds up the totals, as indicated by the punch marks and also automatically sorts out from the general pile all the cards relating to any one job. This is not done as with the familiar computing machines used in every bank, but sorting and adding are done automatically in the machine itself, as the cards pass through. In fact, it would seem that no one is safe in setting a limit to what may or may not be done from one year to the next.

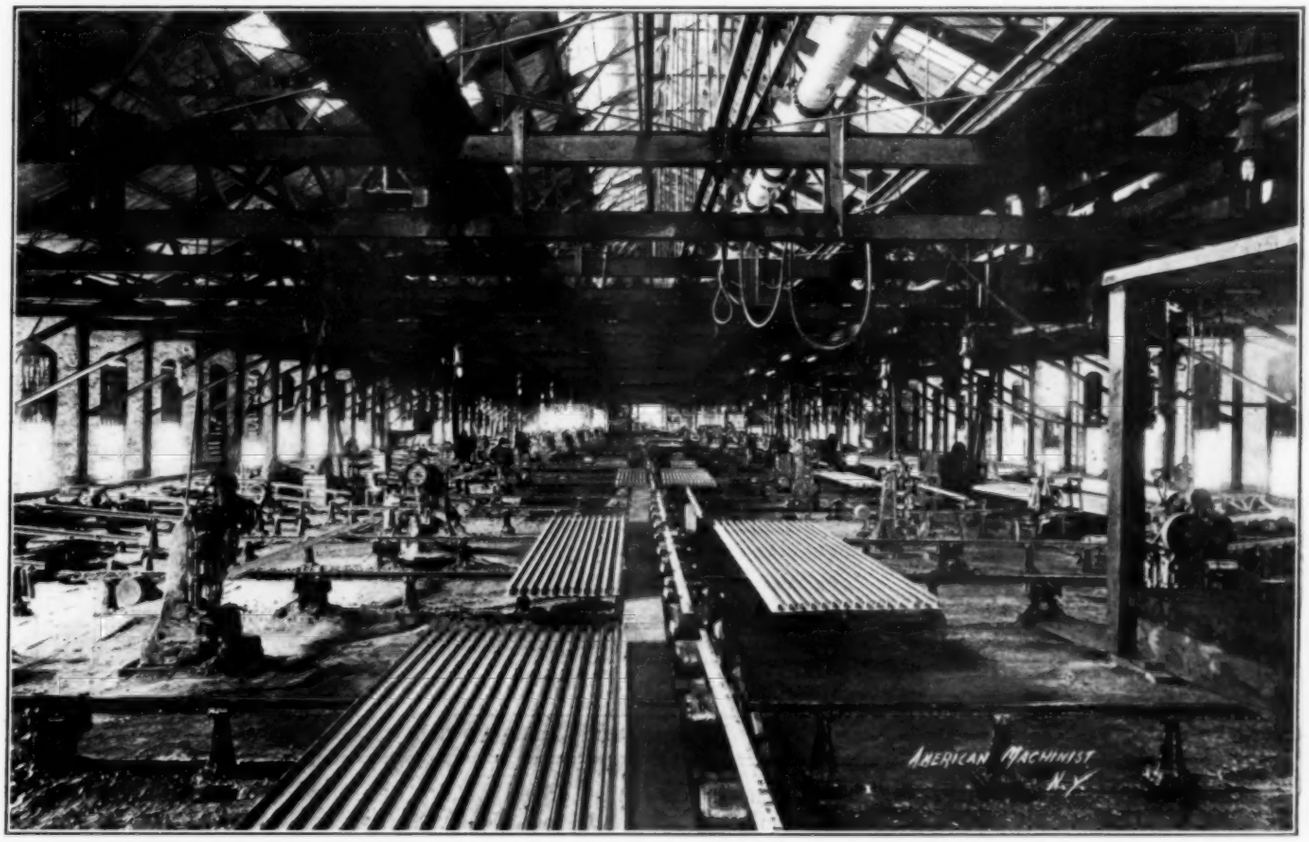


FIG. 9. RAIL MILL FINISHING SHED, LACKAWANNA STEEL COMPANY

Erection Drawings for Machine Tools

By Mark Dale

Some time ago I had to do with the locating and placing in position of a number of machine tools; I had to get out a plan showing the new tools in relation to the existing plant. To save as much room as possible the new tools had to be located among the old ones and these had to be arranged and pulleys ordered, overhead carrying arrangement fixed up, etc., before the arrival of the machines. All I had to work from was the erection drawings supplied by the makers. Now owing to the insufficient particulars given on the erection drawings I found this work very difficult to accomplish with any degree of accuracy beforehand, owing partly to the variety of the machines, but particularly owing to insufficient information in regard to the overhead gear.

It is with the view of getting the makers to supply a little more information on these erection sketches that this is written.

If we only had the floor areas to contend with there would be little difficulty, but it is with the countershafts that the trouble lies. In getting out a plan the following are some of the points that must be watched: Floor space of machine in relation to existing machines; area required for countershaft; position of striking gear

in relation to the main shaft; position of new driving pulleys on main shaft in relation to existing pulleys, couplings, bearings, etc. The countershaft of a grinding machine was so arranged that it could be driven from one direction only—from a main shaft at the front of the machine; whereas ours was located at the back. Some of the erection sketches gave most of the required information but required a lot of puzzling out; then again some of the machines had been ordered—through agents—from America who apparently supplied us with sketches they had in stock but which differed from the sketches that came with the machine. A little more care in making out these erection sketches would save a lot of trouble and time.

Some Facts About Oxy-Acetylene Welding

By W. I. Reich

The autogenous oxy-acetylene welding process was introduced in this country in 1906, at the Fore River Shipbuilding Company, Quincy, Mass. Since then it has made rapid strides, principally in the sheet-metal work. Its success is due to the inexpensive installation, and the rapidity with which any intelligent workman can acquire the art of welding. Small shops can easily install portable welding outfits for a few hundred dollars, and turn out a variety of welded work that heretofore only large shops equipped with expensive tools could undertake. The welding process is most useful in the sheet-metal line, where coke and water gas cannot be employed.

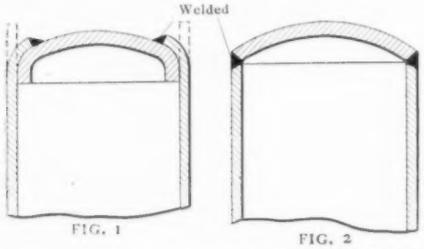


FIG. 1 FIG. 2

American Machinist, N.Y.

TWO STYLES OF WELDING

The oxy-acetylene welding process is practically limited to steel plates up to ¾ inch in thickness. For thicker plates we have to employ gas welding, with lapped joints, or coke welding. In coke welding the heat is supplied from one side only, while in gas welding two blowers can be used to heat the metal on both the top and bottom, hence the greatest efficiency in the welded joints is obtained by the latter method.

From some tests of Professor Ledebour we know that a good quality of steel will lose its fibrous structure after heating it to about 1850 degrees Fahrenheit, and cooling it in the air without working it. It may regain its old quality by annealing. The oxy-acetylene welding process will heat steel to a much higher temperature than this and, therefore, it destroys the fibrous structure, but this may be brought back by hammering or pressing the metal. The hammering or pressing breaks up the coarse crystals that have been formed by the high heat and brings them in closer contact with one another, thereby strengthening the metal.

The oxy-acetylene welding process is actually only a method for fusing the edges together. We, therefore, should never expect a joint with 100 per cent. efficiency, on rolled or forged metal, as the process means merely the joining of these together with cast steel. Even a high grade of Norway iron fused in this manner will produce but a good grade of cast steel. Of course, this can be largely overcome by increasing the thickness of the metal at the joint wherever it is possible. The crystallization or molecular distortion which occurs on each side of the weld, due to its being overheated by the local application of a very high temperature in the weld, is not so easily overcome, but a thorough annealing of the joint after welding will remove this crystallization to a large extent. Furthermore, the rapid cooling from the sides is liable to cause "piping," or shrinkage cracks in the joint, similar to that which is produced on a larger scale when casting steel ingots, or in making ice blocks, when the outer wall cools too rapidly. In the latter cases the evil is partly remedied by keeping the core liquid as long as possible.

Some tests on oxy-acetylene-welded joints were made by the writer under the following conditions: Steel sheets up to ⅛ inch were butted together and welded without fusing in any additional metal; heavier plates were chamfered at an angle of about 45 degrees and welded by fusing in the V an open-hearth steel rod. The original stock and the welded pieces were cut to the same uniform size for test pieces. All test pieces were annealed before testing. Aluminum was also welded and tested under the same conditions. The results of these tests are shown in Table 1.

The chemical properties of the steel have an important influence on the welded joint. The most suitable steel is open-hearth, with a limit of carbon content of 0.60 per cent. and a normal content of from 0.15 to 0.25 per cent.; a maximum sulphur and phosphorus content of 0.05 per cent., and a normal content of from 0.02 to 0.03 per cent.; maximum of the silicon content, 0.15 per cent., and manganese, 0.7 per cent.

From the table we can see that the elastic limit in steel drops about 8 to 10 per cent. after welding, and the ultimate strength about 20 per cent. A considerable drop of the elongation, in the welded joint, is also very noticeable.

	Original Stock.				Welded Joint with Oxy-Acetylene.		
No. of Tests.	Thickness, Inches.	Elastic Limit.	Ultimate Strength.	Elongation.	Elastic Limit.	Ultimate Strength.	Elongation.
6	¾	37,000	53,000	19%	29,200	41,500	10.2%
6	½	28,000	46,200	30	28,000	35,800	5
6	⅜	25,600	45,000	32	24,000	36,000	8
6	¼	23,000	44,500	36	26,600	44,500	6
3	⅛	28,700	48,000	35	25,000	37,500	7
		Tests of Aluminium.					
4	¾	8,400	14,700	26%	9,200	12,600	8%
4	½	5,900	19,600	30	5,500	14,000	20
4	⅛	5,900	15,800	19	5,300	9,000	5

TABLE 1. SOME TESTS OF OPEN-HEARTH STEEL BEFORE AND AFTER WELDING.

	Time.	Labor.	Gases.	Total.
10-foot longitudinal seam ¼ inch thick	2 hours	$0.60	$0.70	$1.30
Two 5-foot circular seams ½ inch thick	3 hours	0.90	2.20	3.10
Total	5 hours	$1.50	$2.90	$4.40

TABLE 2. TIME AND COST IN WELDING TANKS.

The welded aluminum joints showed fairly good results, although the elongation seems to be somewhat irregular.

Some further tests were made on welded tanks 20 inches in diameter and 10 feet long; the cylinder was ¼ inch and the head ½ inch thick.

The heads were welded in two ways; Fig. 1 shows the head flanged and forced in, and finally upset cold, and Fig. 2 shows the head butted together with the cylinder. Both methods were equally good as far as the point is concerned, but that in Fig. 2 was more expensive, since the head was turned in a lathe. The cylinders were rolled to size from soft-steel plates in one case, and in the other case lap-welded pipes were used.

The first tanks were welded by an inexperienced welder on heavy work, with the following results.

The tests were made with hydraulic pressure, with 100-pound increments and complete release. The first tank burst in

the longitudinal joint at 250 pounds pressure, representing 10,250 pounds per square inch. The second tank burst in the same manner at 500 pounds pressure, or at an ultimate strength of 20,500 pounds per square inch.

The second lot was welded by a better welder. Two of these tanks burst at about the same pressure of 850 pounds, or an ultimate strength of 34,850 pounds per square inch. The circular seams did not burst during the test. The longitudinal seam was about 70 per cent. of the efficiency of the stock, which tested up to about 50,000 pounds ultimate strength. Some of the longitudinal seams of the pipes burst at about 60 per cent. of the ultimate strength. Their thickness was ⅜ inch as against ¼ inch thickness of the welded cylinders.

Better results could have been obtained by preheating the metal before welding, and annealing it after the tanks were welded. These tests show that the oxy-acetylene-welding process can be safely employed for high-pressure tank welding. There is a decided economy of the longitudinal-welded seam over the lap-welded commercial pipe, since a smaller section can be used with the same safety.

The cost of welding for the above tanks was as given in Table 2. From the above data we can safely draw the following conclusions:

1. Do not let inexperienced welders do responsible work, which has to stand high pressure.

2. Pieces with alternate stresses, such as axles, should not be welded with the oxy-acetylene process.

3. Do not expect a better efficiency of the joint than 80 per cent.; 70 per cent. is a good average.

4. It is not safe to weld an unstayed surface in a firebox, as the expansion and contraction from the heat of the fire may crack the joint.

5. When welding long joints in plates with combined stresses of bending and tension, add about 25 per cent. to the thickness by fusing in sufficient metal.

6. Plates above ¾ inch in thickness should be welded from both sides, if possible, as the joint then will be more reliable.

7. Plates above ¼ inch in thickness should be preheated, and if possible heated from one side while welding the other.

8. Heavier plates or pieces should be hammered with light and rapid blows, to work the metal, until being cooled to dark red heat.

9. The oxygen must be free from chlorine; a purity of 25 per cent. is desirable, and if made from liquid air it should not contain over 10 per cent. of nitrogen. The barium and electrolytic process also furnishes a good quality of oxygen.

10. The acetylene must be free from polymerized gases, which is the result of too rapid generation and overheating of the gas. The joint welded with impure gases will be in most cases defective, no matter how skilful the operator is. Furthermore, a rapid generation of acetylene will develop a fine calcium powder on the surface of the water, which may find its way to the tip of the blow pipe clogging its orifice, or it may be carried into the joint, causing a defective weld. The trouble of too rapid generation of acetylene is inherent in all generators that were designed for lighting and then adopted for welding purposes. The water seal cannot retain the fine powder, since in a rapid generation the gas bubbles are in comparison large, and in the center of these is carried along the aforesaid powder. With a large generator we do not need a filter as the water seal acts as a scrubber and takes out all the impurities.

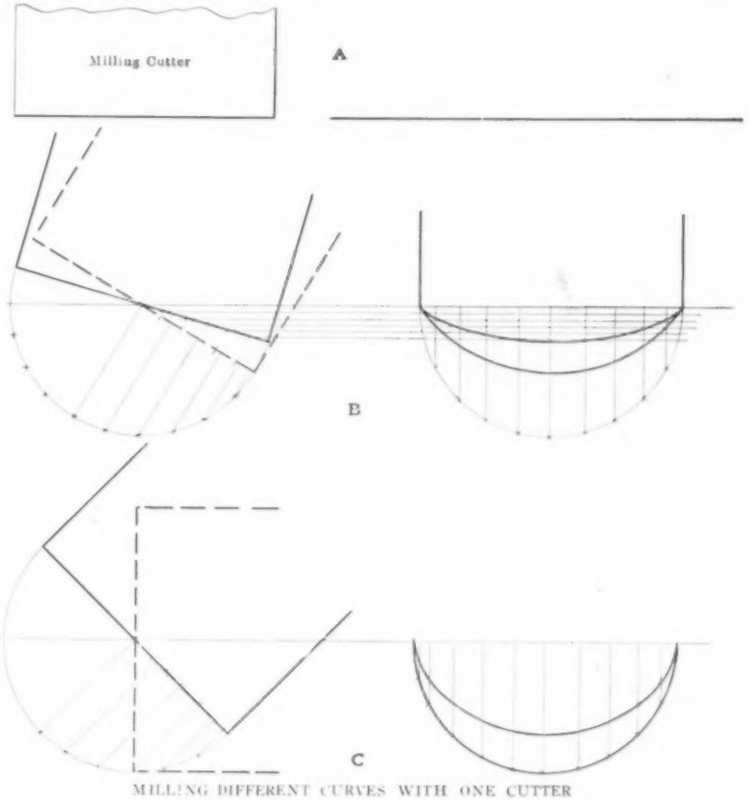
Milling Different Curves with the Same Cutter

An interesting, practical example of the varying curves assumed by the end of a cylinder when chipped to different angles was recently shown by the Waltham Watch Tool Company, Springfield, Mass., in connection with their Van Norman milling machine.

An end mill was used, being first set in a vertical position so as to mill a perfectly flat surface. It was then turned through different angles and a cut taken, producing a large variety of curve depressions, all perfectly true and regular, but of course, changing with each angle and presenting a variety of elliptical curves.

At *B* is shown what will be produced by the two cutter angles occupied by the cutter at the left, while at *C* is a more extreme angle ending with a perfect half circle obtained by swinging the milling cutter into a horizontal position.

There is, of course, nothing new in this, and is an easy matter to lay out curves from any angle of the cutter so as to show just what will be secured by it, and while it may not have a wide field of usefulness, there are certainly places where it can be used to advantage with a little consideration regarding the diameter of the cutter and the angle at which it is set.



MILLING DIFFERENT CURVES WITH ONE CUTTER

The most important industry among the vegetable-oil industries is the cotton seed, and it is today one of the most important industries of the United States. From being but a short time ago but an incubus that cotton operators did not know what to do with, it has become one of the great wealth producers of the nation. There are grown in the United States about 13,000,000 bales of cotton annually, each bale weighing 500 pounds, which amounts to six billion, five hundred million (6,500,000,000) pounds of cotton. For every pound of cotton there are 3 pounds of seed, giving a yield of 19,500,000,000 pounds of seed, valued at about $200,000,000. There are about 800 cotton-oil mills in the United States which are engaged in crushing and pressing this mountain of seed for its oil, aside from that used for planting purposes.—*J. of F. I.*

Magnetic Separators for Various Uses

Separating Iron Products from Sand, Slag, Coke, Coal, Brass, Scrap, Junk and Many Other Non-magnetic Materials, Savings Effected

BY S. R. STONE

Among the economies practiced in machine shops, foundries and metal-working establishments of various kinds, few are more suggestive than the use of magnetic separators, the principal applications of which, as thus far developed, will be found briefly outlined in the following article:

The halftone, Fig. 1, and the line cut, Fig. 2, show the type of machine now most commonly used in brass foundries and metal refineries for removing iron and steel from brass and copper turnings, borings, filings, punchings, fine scrap, washings, skimmings, etc., preparatory to remelting in the furnace or crucible. This is of the so-called "disk" pattern, and its operation is as follows:

The material to be treated is fed from

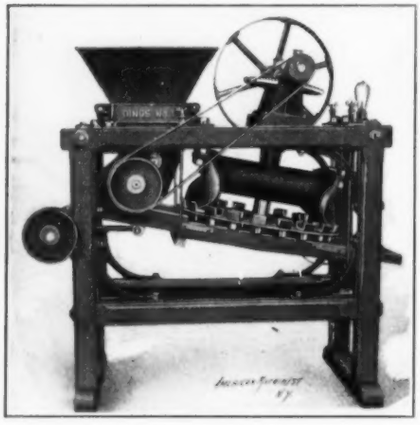


FIG. 1. DISK PATTERN SEPARATOR

the hopper *A* upon a vibrating conveyer *B*, over which it passes in a thin layer through the zone of operation covered by the rims of the wheels *C* carrying secondary magnets, *D D*, which attract the iron and steel, thereby separating it from the other metal, and discharge it over the sides of the conveyer into spouts.

The secondary magnets are saturated by the pole pieces *E E* of the primary magnets while over the conveyer, but are automatically demagnetized as they pass out of the magnetic circuit *F F* to the neutral position, where the rims of the wheels *C* overhang the conveyer. The non-magnetic material to be recovered passes off to final delivery at *G*, the lower end of the conveyer. At *H H* are located thumb screws for adjusting the inclination of the shaker *B*.

Separator for Foundries

This type of separator is the one which has thus far been most widely installed, but there is every indication that in point of numbers used, as is already the case with respect to the tonnage of metal recovered, it will be far outstripped in the near future by the machines designed for foundries. Views of two of these are shown in Figs. 3 and 4.

Fig. 5 illustrates one of these separators with the side guards removed and the several parts indicated by lettering. In this *A* is the hopper, *B* the revolving screen and *C* the magnet section. In operating it the sand comes out at *D*, the coke and slag at *E* and the iron at *F*. The sand, coke and iron can be collected in wheelbarrows placed under the separator as shown in Fig. 4, or they can be dropped into bins and removed by a conveyer. It is used to recover iron from refuse, such as cinder-mill droppings, gangway scrapings, chipping-room dirt, etc., and has been built especially to suit the requirements of that particular class of service, being now one of the most important parts of the equipment.

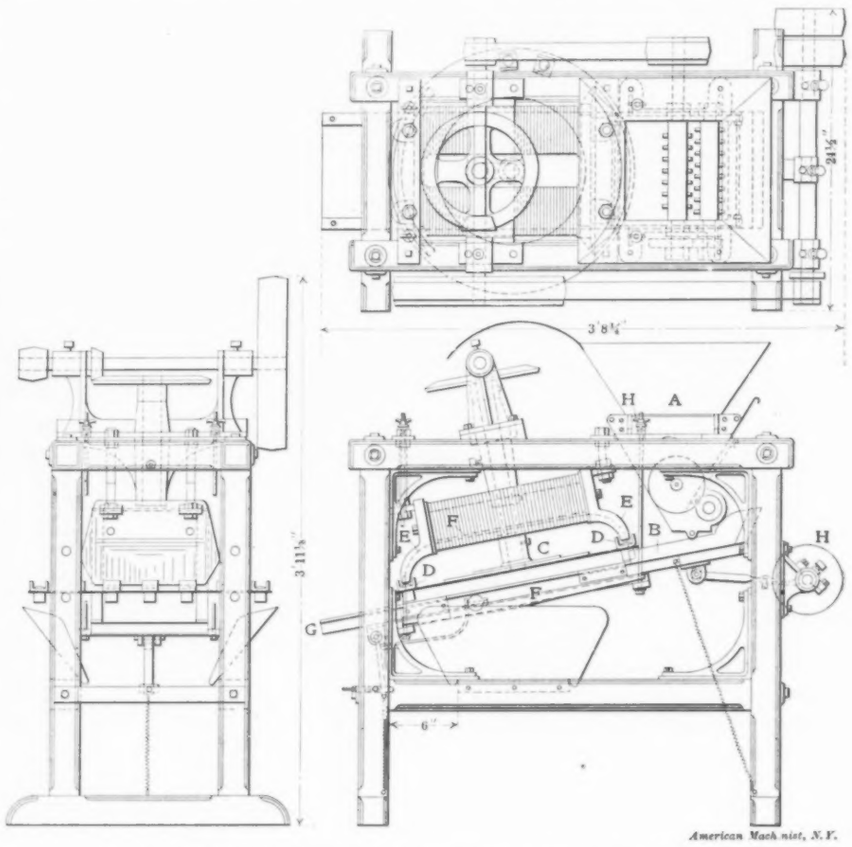


FIG. 2. LINE CUT OF THE DISK SEPARATOR SHOWN IN FIG. 1

Savings Effected by Separator

"Our old method," said an official of one of the large malleable iron and steel companies, whose experience is typical, "was riddling the sweepings from the foundry floor, and we estimate that we are now saving from one to one and a half tons of additional iron daily. We expect to do even better than this, as we are making the plant more complete by putting in a large rolling barrel to crush the cinder from our cupola and open-hearth furnaces." Others interviewed on the subject stated that they were recovering large quantities of iron which had heretofore been absolutely lost to them.

Where the refuse from the furnaces and molds, as well as the finer material mentioned above, is regularly put through this process, going back to the cupolas to be melted over again with the pig iron and scrap, one foundry estimates that a saving of between twenty and thirty thousand dollars is effected in the course of a year, depending upon the tonnage of iron originally melted.

Operations of Separator

To illustrate the working of the system let us take cinder from a cupola, a very large percentage of the iron in which was formerly thrown away. This is first crushed in an ordinary cinder mill, and the iron left in the mill is ready for remelting. The screenings, however, contain by weight as much as 20 to 30 per cent. of good iron, and these are next put through the separator.

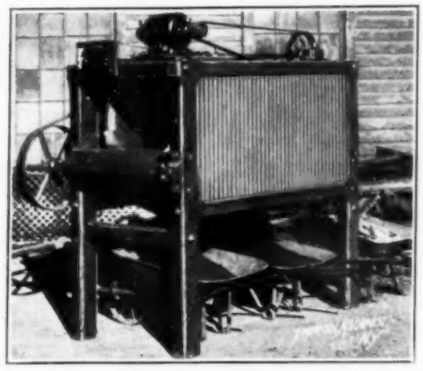


FIG. 3. OUTLET END OF SEPARATOR FOR FOUNDRIES

The material first passes the screen section of the cylinder, which draws off the sand and dust. The coarse part then moves into the magnet section, where the iron is caught by the magnets and carried to the high point of rotation, being discharged upon a perforated incline chute and thus to final delivery.

The coke, slag and other non-magnetic materials pass out of the lower end of the cylinder and are delivered by a back-slanted chute into a wheelbarrow or conveyer.

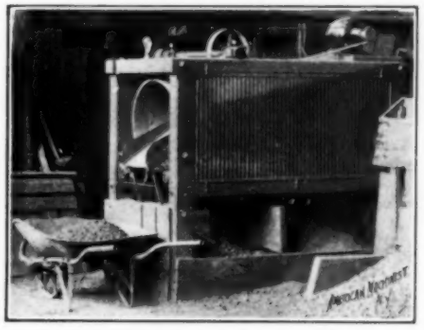


FIG. 4. INTAKE END OF SEPARATOR FOR FOUNDRIES

Besides the actual recovery made of iron, this system effects a further economy, in that it saves at least 75 per cent. in time, power and wear and tear on the cinder mill, which does the work in about one-quarter of the time required, where riddling is afterward to be done. This is because the cinder mill may have larger openings between the staves. The fact that less labor is needed is also quite a consideration.

Materials Separated

In handling the refuse from the molds, and the foundry and cleaning-room floor, three separations can be made, viz., sand, slag and iron. The sand is delivered in a condition fit for various uses in the foundry, the coarse pieces of slag may be used for venting large cores, and the iron is ready for remelting, being sufficiently clean to require no further sifting.

In handling the floor scrapings, chipping-room dust, etc., the material does not, of course, need any crushing, but is simply shoveled into the separator without further preparation.

Another use to which magnetic separators have been put in the foundry, with considerable advantage, is in connection with continuous molding systems where slop, etc., in the form of fine shot is separated from the sand when it leaves the conveyer on its return journey to the bins, thereby enabling it to be used over and over without any further treatment than the addition of the fresh sand needed. From the fact that the process of separation occurs at a stage when the sand is still soft, the particles are broken up and prevented from caking. A feature of the best type of foundry separator is that it cannot be overloaded so as to lose iron.

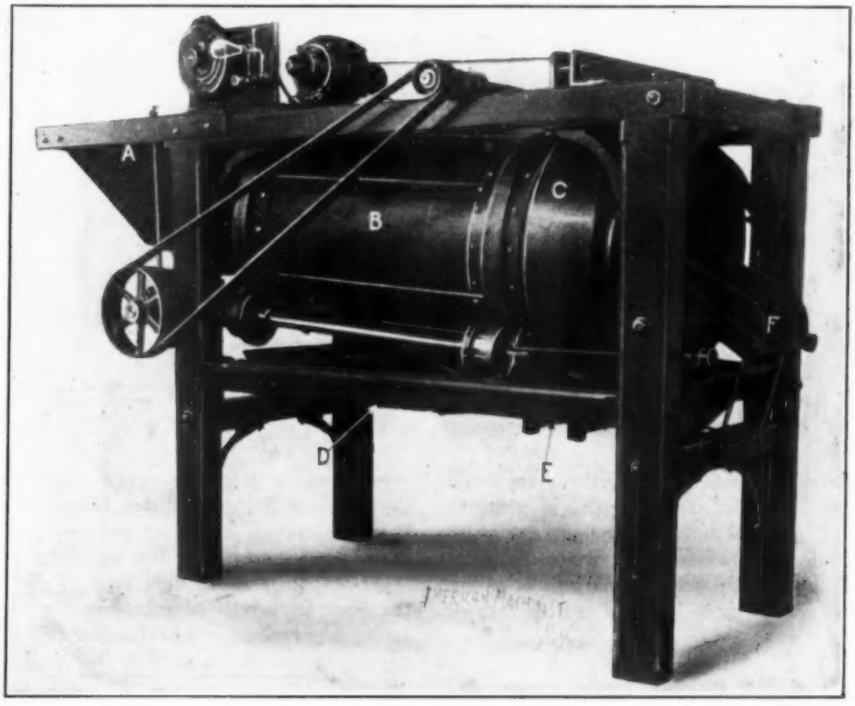


FIG. 5. SIDE REMOVED FROM SEPARATOR TO SHOW ITS MECHANISM

Continuous Discharge

The delivery of the material is continuous, and the magnets successively discharge the recovered iron at the proper point in rotation without breaking the circuit.

If built with a large screening surface and constantly discharging magnets, the separator will handle damp material, such as crushed cinder that has been wet to prevent dust in milling, and it takes care of anything that can be handled with a shovel. Stray bricks, gaggers and large pieces of refuse liable to be found on the floor of a foundry readily pass through the machine.

For its operation only common labor of the most ordinary intelligence is necessary, as there is practically nothing to get out of order. There is no need of having switches, contacts nor brushes to wear out, spark, or burn off, except in connection with a motor used to drive it. This the laborer is not supposed to handle to any greater extent than throwing a small switch.

Electrical Operation

The separator takes up but little space, say 3½x7 feet for foundry capacity up to a melt of 50 tons daily, and it can be readily moved from one location to another, particularly if motor-driven. Electrically operated machines are usually preferred, as one can be set up in any place merely by having a wire run to it, regardless of line shaft, pulley and belting, and is ready for work as soon as connected to the service circuit. Each separator thus equipped should be provided with a motor on a sliding base, for tightening the belt between the motor and arbor, also a starting box, switch panel, and dust cover, or screened ends, for the motor.

The power required for machines of the ordinary sizes ranges from ½ to ¾ horsepower for the mechanical operation and not to exceed ¼ horsepower for the magnet; so that a 1-horsepower motor is or-

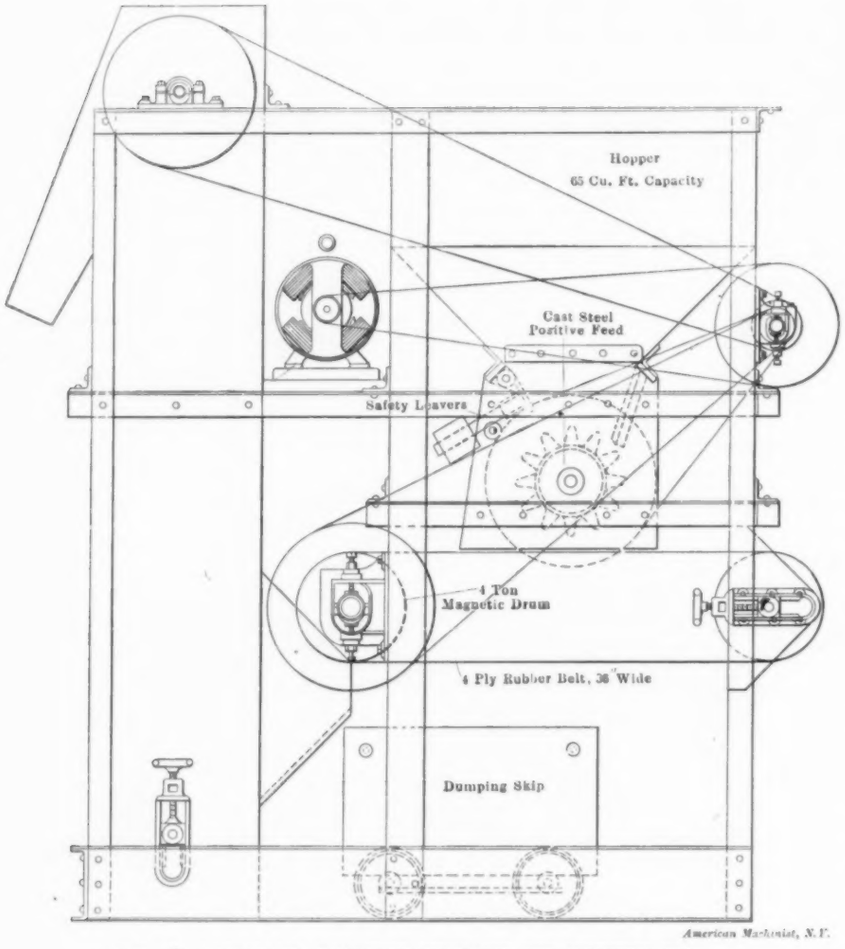


FIG. 5. AUTOMATIC MAGNETIC SEPARATOR FOR FOUNDRY USE

dinarily sufficient. Direct current is, of course, needed, as alternating current cannot profitably be utilized to excite the fields of a magnet; but, where the latter is used exclusively, a small direct-current generator can be installed at little cost.

Conveyer Systems

If the quantity of material handled daily is sufficient to warrant it, considerable saving of operation can be effected, and the net economy thereby increased, by putting in a conveyer system which will deliver the discharge from the cinder mill, or the refuse shoveled up from the floor, directly into the mouth of the separator and then carry the separations to their various destinations.

In Fig. 6 may be seen the side elevation of a machine especially fitted with attachments for use in connection with the conveying or crane system of a steel foundry. By means of this the refuse collected in large boxes at night and brought to a large receiving hopper is carried away on a belt, automatically fed into the separator at a specified rate, and the useless part of the separation elevated to a discharge into cars outside the building.

There is no end to the variety of systems of this kind which can be worked out, at relatively small expense, to suit local conditions.

In planning them, however, provision should be made for ordinary barrow and shovel operation whenever such may be desirable or necessary. For example, the separator must stand high enough above the floor to permit of receiving the different separations in wheelbarrows, if required, and at the same time low enough in the frame to allow for easy shoveling from the floor into the mouth of the cylinder.

It may also be observed here, in general, that every part of the separator should be readily accessible for inspection and repairs without dismantling, and there ought to be no parts unduly affected by the action of rust or frost. The frame must, of course, be built of nonmagnetic material, preferably heavy, seasoned, nonwarping wood strongly braced and bolted.

Savings Versus Cost of Installation

A separator in ordinary intermittent operation ought to pay for itself in three months or less. If working on an old dump continuously, thirty days should be sufficient to cover the initial cost, as was the case recently at an iron foundry within two miles of where this article was written. The first machine of the type shown in Figs. 4 and 5 was installed in a 50-ton-per-day foundry about eight years ago, and has been in continuous operation ever since, having effected a saving in that period equivalent to not less than 40 times its cost, including labor.

A couple of old foundrymen who rigged up a portable outfit, with a small gasolene engine as the motive power, and made contracts to clean up dump heaps in the neighborhood of some large iron-working plants, were, at last accounts, clearing an average of fifty dollars per day over their expenses, and they hired laborers to do the actual work.

Dust From Blast Furnaces

One of the most enterprising of the iron-producing companies of the country is now considering the installation of magnetic separators with which to recover both iron and coke from the dust blown out at the tops of the blast furnaces. The

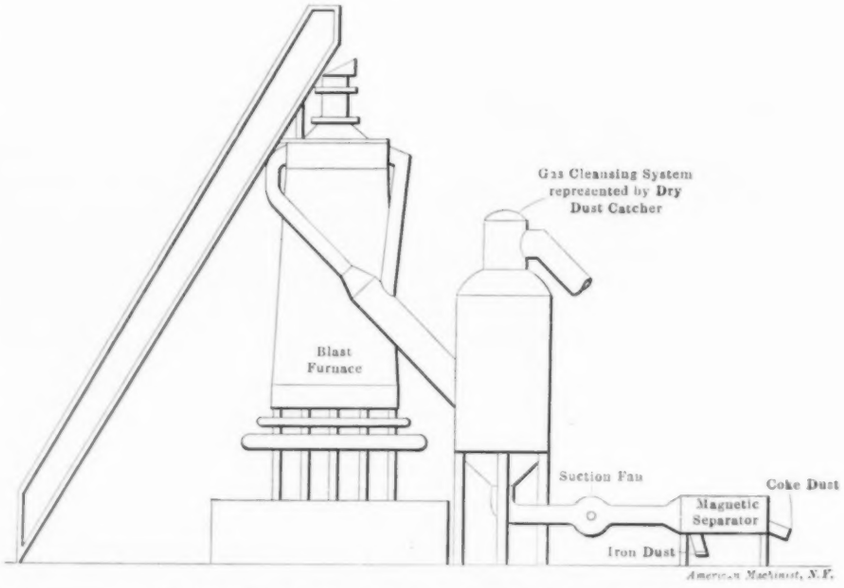


FIG. 7. SEPARATING IRON AND COKE FROM BLAST FURNACE DUST

construction of this is shown in the line cut, Fig. 7.

The scheme is to have this dust pass from the hood of the furnace into a large pipe known as a downcomer and then into a settling tank, from the bottom of which it will be drawn off by a vacuum suction system into a magnetic separator, where the two principal materials will be sent down different chutes into larries and taken thence to be nodulized for re-use in the furnace.

The details of the plan have not yet been worked out to the satisfaction of those who are responsible for it, but there can be little doubt that it will eventually mean one step more in the great movement of the iron and steel world for eliminating waste.

Separating Coke, Emery, Carborundum, etc.

In Fig. 8 is reproduced a photograph of the principal parts of a type of separator installed in one of the largest by-product coke plants of the country, and Fig. 9 is a line cut showing it more in detail. The object of this separator is to remove, from the coal, material such as old railroad iron, pickheads, shovels, etc., which would damage the crushing rolls; and, incredible as it may seem, one coke plant well known to the writer shows an average of about one ton of metal diverted each week from the crushers. To insure that none of it gets past the separator, an independent guard magnet is constructed at the discharge end of the belt, but this seldom comes into action, as the lines of force concentrated in the regular zone of separation are sufficiently powerful for all ordinary purposes.

Not less interesting than anything contained in the foregoing is the use of separators for recovering emery, corundum, garnet dust and other abrasives used on belts for polishing heavy blades. The first application of this kind was made in a plow works. At first some difficulty was experienced on account of the glue with which the abrasive material was secured to the belt and which was worn off with it, but this was overcome by first soaking the material in soda water and draining off the solution. With the separator about fifteen dollars worth of abrasive is recovered in one plant each day, and it is very nearly as good as when first used.

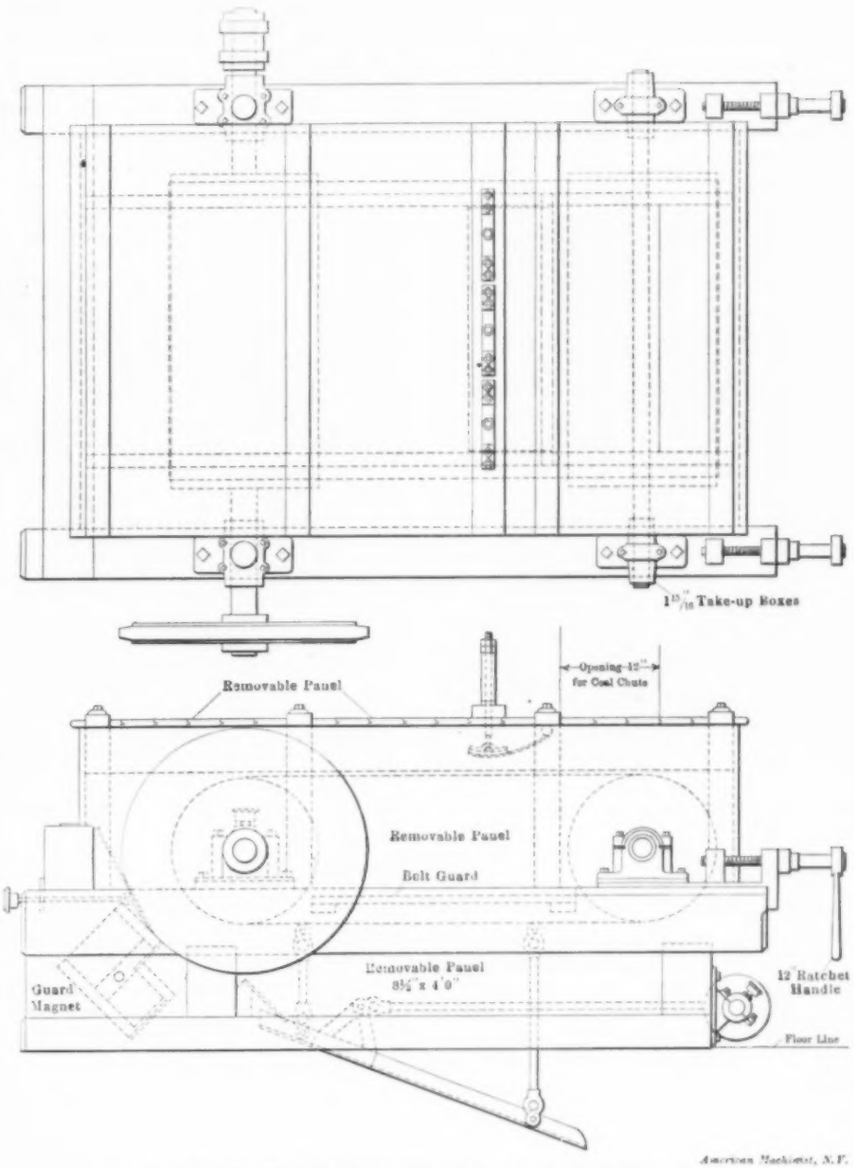


FIG. 9. DETAILS OF SEPARATOR FOR REMOVING IRON FROM COAL

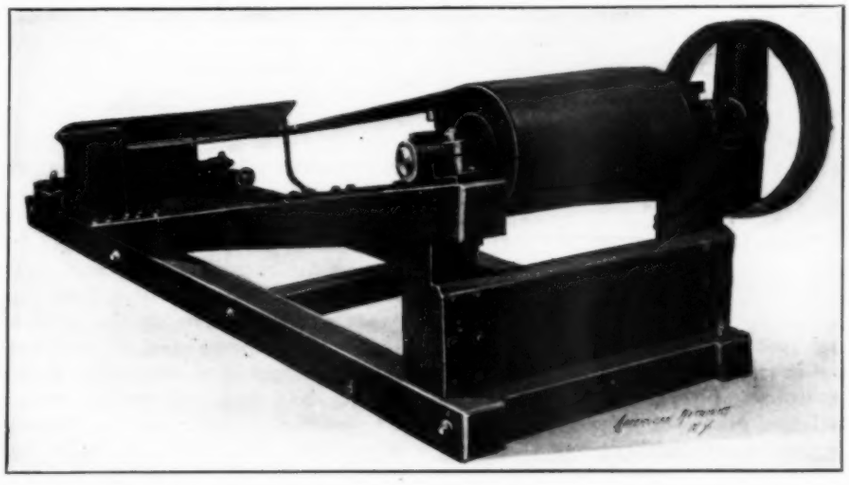


FIG. 8. SEPARATOR USED FOR REMOVING IRON PRODUCTS FROM COAL

Belt Separators

Two types of separators, one of which shows magnets underlying a belt and the other merely a magnetized pulley, are illustrated in Figs. 10 and 11.

Another field of usefulness for magnetic separators which, while not of direct interest to machinists and founders, has considerable suggestive value, is the elimination of bits of metal such as buckles, nails, pins, hooks and eyes, etc., from textiles, leather or rubber scrap, paper waste, etc. These are usually ground up for retreatment in the mills or factories using such material. Other uses similar to that described for coke plants, where pieces of iron or steel that would be injurious to the machinery are removed at

some stage of the process, include the treatment of bones, hoofs, etc., in glue factories; tobacco stems in snuff works; grains in malthouses and distilleries; herbs and minerals in drug mills; and ground meal in flour mills.

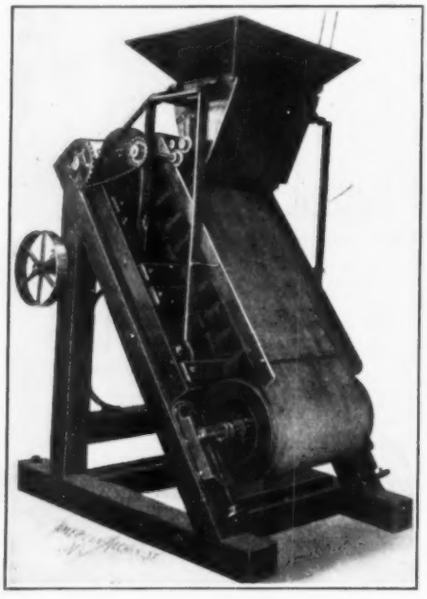


FIG. 10. SEPARATOR WITH MAGNETS UNDER BELT

Still another use for magnetic separators is in preventing damage to the grates of furnaces in power plants by having pieces of iron or steel pass in with the coal. A very simple guard consists of a magnetized grizzley placed in the delivery chute, but it is sometimes inconvenient to get at such a contrivance to remove the iron that adheres to it, and a better arrangement could probably be made in

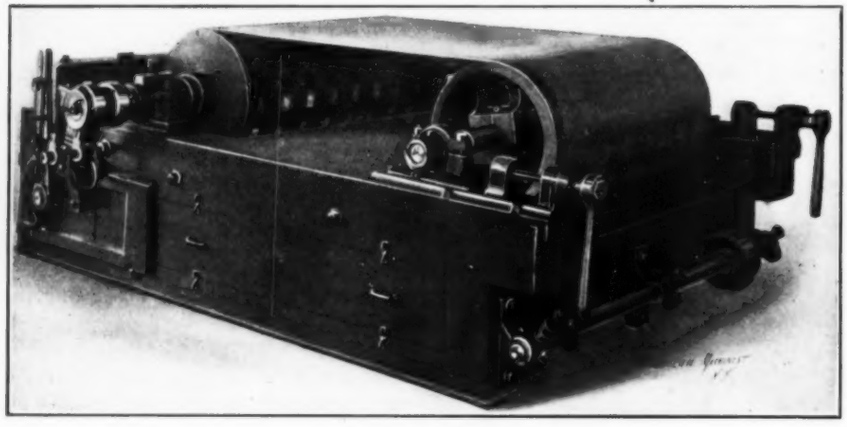


FIG. 11. SEPARATOR WITH MAGNETIZED PULLEY

most cases, depending upon the particular conditions encountered.

Use in Ore Reduction

In the field of ore reduction magnetic separation has, for some years, been extensively used, either on materials naturally magnetic or that have been rendered so by being converted into oxides through roasting. The separations tried have thus far included treating magnetite iron ore, eliminating iron pyrites from zinc blende, recovering the copper values from chalcopyrite ore, concentrating tungsten, garnets, monozite and other rare minerals, separating wolfram from tin ore, apatite from hornblende, and cobalt, nickel, etc., from the worthless gangue in which they are found.

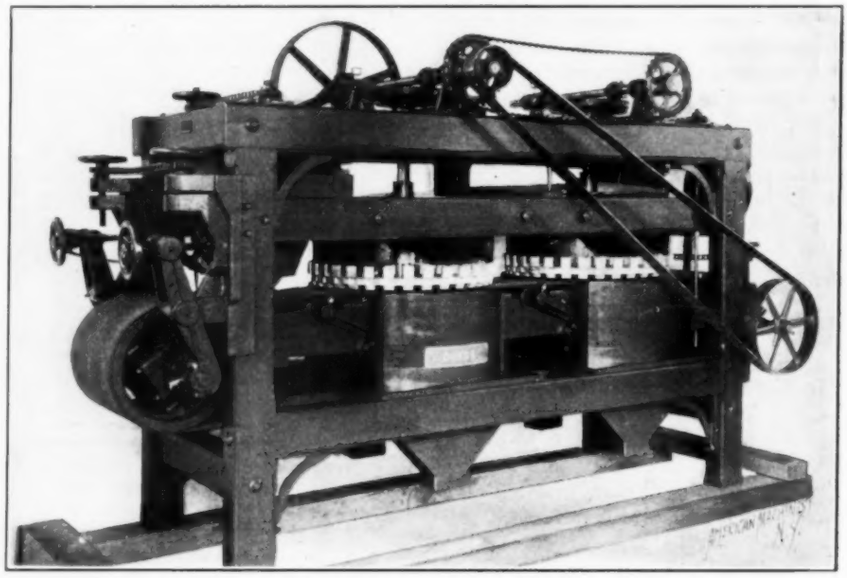


FIG. 12. TYPE OF SEPARATOR USED IN ORE REDUCTION

In Fig. 12 is shown one of the standard separators used for this work, which is similar to that illustrated by Fig. 1, except that it has a double magnet, each part of which is much more powerful than any used for other styles of separators and is capable of making five separations, consisting of the nonmagnetic material and four grades of magnetite of various degrees of attractibility.

This subject is such a large one that to treat in more detail the various phases of it mentioned in the foregoing would require an extensive series of articles, but enough has doubtless been said to indicate the profit of considering it with relation to the requirements of any individual foundry, shop or specific industry. For the illustrations the writer acknowledges indebtedness to the Dings Electro-Magnetic Separator Company, of Milwaukee, which is building these machines.

The Running Balance and How It is Obtained

The balancing of pulleys and other revolving bodies is being more carefully considered than ever before, and the matter of running balance as distinguished from, or rather in addition to, standing balance is receiving more attention. The use of balancing ways, which must simply be

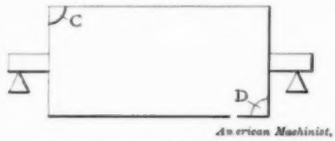


FIG. 1. BALANCING A DRIVE

smooth and level, is well understood, and it is an easy matter to obtain perfect balance in this way, so that a pulley or drum will stand in any position. That this does not indicate running balance can readily be seen by Fig. 1, where a drum may stand in any position on the balancing ways if loaded at *C* and *D* with equal weights, though it is very clear that in running, both ends will tend to move in different circles, and a decided "wabble" be produced which would be fatal to high speed.

The whole secret of a running balance

is to make the center of gravity coincide with the center of rotation which, in the case of Fig. 1, would be secured by placing equal weights at points opposite to *C* and *D*, providing this did not throw out the standing balance already secured.

Assuming that weights *C* and *D* were needed to secure standing balance, we could not place other weights opposite, but must find some location for these weights which will put the center of gravity in the right place for both standing and running balance. In the case of pulleys and similar work this is the object of the balancing machine shown in Fig. 2 and made by the Defiance Machine Works, Defiance, Ohio.

For the best results a machine of this

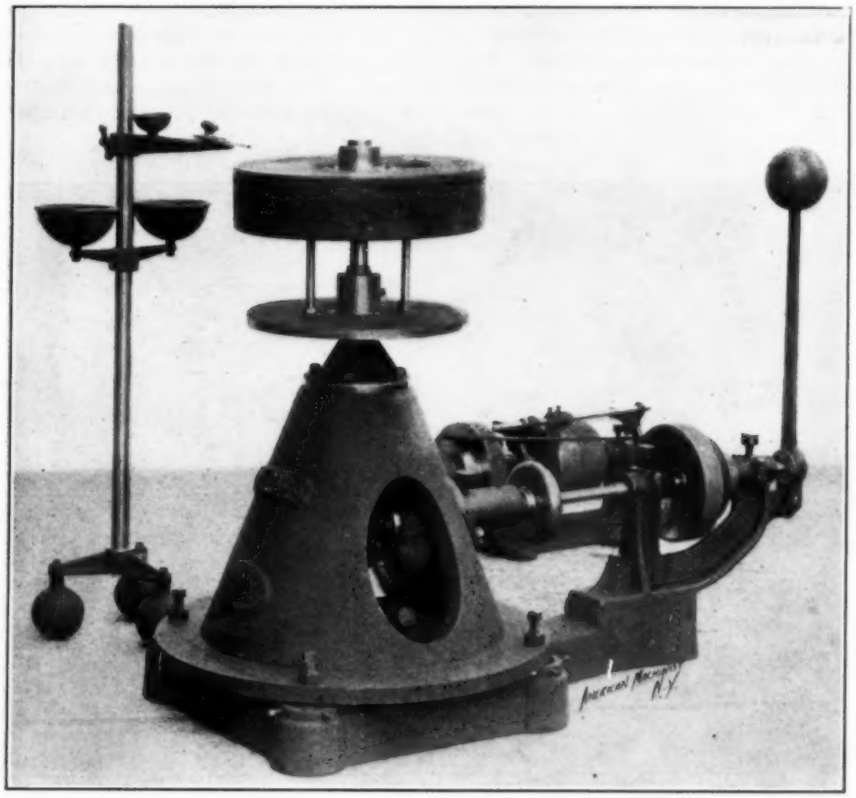


FIG. 2. BALANCING AN AUTOMOBILE FLYWHEEL

kind should be set on a concrete or other solid foundation and accurately leveled by the screws shown. The vertical spindle is driven by a pair of friction cones and the power is transmitted to these through a friction clutch just outside the bearing. The weighted-ball lever controls this clutch, holding it in or out of control, as desired.

The first step is to secure the standing balance by the use of balancing ways, using adjustable weights, usually small cast-iron cups filled with a clay of rather peculiar consistency, which sticks it to the inside of the rim and yet allows it to be moved at will. These are placed about the center of the rim. Then, in the case of a six-armed pulley, as in Fig. 3, a piece having a cup center that will bring the balancing point in the center of the pulley hub is slipped into the bore, the lever moved toward the machine which throws in the clutch, and the work is revolved very rapidly. Then the clutch is thrown out to allow it to revolve by its own momentum and entirely free of driving strain, and, while running free, the high spot or spots on the edge of the rim are marked by a pencil of moistened clay or chalk held by the operator over the arm rest.

If the mark occurs within one-quarter of the circumference of the wheel from the weight, in the direction of rotation, raise the weight and at the same time advance it toward the mark on the rim. Should the mark show at more than a quarter of the circumference from the weight, lower the weight and move back from the mark.

It sometimes happens that the weight is moved clear to the edge of the wheel before a perfect balance is secured. In this case the weight must be increased and a counterweight representing the extra weight added must be placed exactly opposite both as to diameter and length as at *A* and *B* in Fig. 3. In any readjustment of weights care must be taken that the standing balance is maintained at all times.

If, upon the readjustment of the first weight the mark shows at one-quarter the distance from the weight, there is nothing more to do with this weight, but an additional weight must be placed right at the mark. Should this second weight disturb the standing balance, this can be restored by an equal weight on the other side.

In some cases, as where an automobile-motor flywheel is being balanced, no weights are permissible, so that the opposite course must be pursued and metal drilled or cut out at a point opposite both as to length and diameter as at *A* and *B* in Fig. 3. Trial weights are sometimes used to give an idea as to the amount of metal to be removed.

In balancing cutter heads for woodworking machines or similar pieces that are long as compared with the diameter and cannot be handled on the machine shown, the cutter head is usually laid loosely in supporting bearings and driven by a light endless belt running directly on the shaft or turned portion of the head. The shaft is then marked at the ends outside the bearings as when truing a piece in the lathe, but it must be borne in mind that the mark will occur on the *light* side instead of the heavy side as seems likely until we give it a second thought.

In a fixed bearing the heavy side will

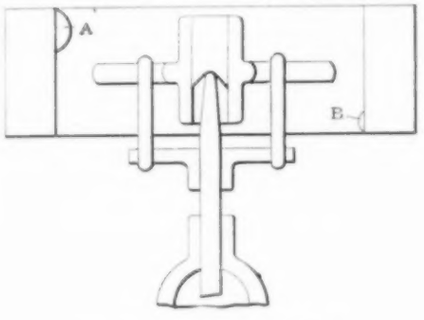


FIG. 3. BALANCING A PULLEY

throw out, but running freely the center of gravity becomes the center of rotation which draws in the heavy side and throws out the light side, so that is the one marked by the chalk.

The importance of proper balancing can hardly be overestimated in the case of high-speed machinery and the experience of those who have worked the matter out to a practical conclusion can do much for the advancement of mechanical construction by giving out their methods.

From the annual report of the Block Signal and Train Control Board to the Interstate Commerce Commission of the United States it is to be noted among the more recent developments which are receiving considerable attention by those interested in the subject of signaling and control are the alternating-current track circuits for electric roads, effective without inductive bonds or insulated joints, transmission of signals by Hertzian waves, magnetic or inductive effects upon the track without mechanical or electrical contact, involving to some extent such principles as the non-magnetic properties of manganese steel rails.

Furnaces for and Methods of Hardening

Coal and Gas Fired; Barium Chloride, Lead Pot, Muffle, Oven and Oil Tempering Furnaces. Methods of Hardening, Annealing, Tempering, Etc.

BY C. U. SCOTT

I have noted with considerable interest the different descriptions and illustrations of the hardening departments shown in the AMERICAN MACHINIST and, therefore, add this one with a view of helping someone out of the smoke and dust into a clean well lighted hardening room, at a very small cost when compared with the great saving effected in labor. In many cases an investment of a few hundred dollars, to properly equip a hardening room will pay for itself many times over in saving of labor alone.

The hardening room, herewith illustrated, has grown from a common blacksmith's forge to its present equipment in about five years, and it will equal any tool-hardening department that I have seen in the middle West. The work done now is far superior in quality to that done with the old forge fire, and fewer men are employed in the hardening room, while the shop force has been more than doubled. The grinding after hardening also costs much less than under the present conditions.

While it was next to impossible to do some work in the forge yet it must be done somehow, regardless of cost. A good illustration of this is in the manufacturing of high-speed screws. When we used the forge for heating we had some saws to harden that were 2¾ inches diameter and 0.04 inch thick. There was 0.025 inch left for grinding and our loss in the hardening amounted to about 12 per cent. while their quality, after hardening, would in no way compare with the ones now manufactured. First, they had to have 0.012 inch of stock ground from each side, and then the face of the tooth had to be ground; that is the face of what teeth there were left.

Now these saws come to us for hardening with only 0.005 inch left on a side for grinding, and one-third of this is for clearance, while the face of the tooth is not ground at all. Reamers and drills also come in for their share of grinding with the same or even more allowed for grinding. In fact all high-speed steel tools required more time to grind than tools hardened with our present facilities.

COAL-FIRED FURNACES

The first furnaces installed were built up with brick and bound together with steel straps as shown by furnaces 1 and 2 in Fig. 1. These two were natural-draft, coal-fired furnaces that were built by the company. They are fired twice each day. In the evening they are fired with anthracite coal with sufficient draft left on during the night to burn out all of the gases, etc., and leave nothing but red coals in the morning, at about the proper heat for hardening. The fires are then shaken down or cleaned and on top of them is placed about 4 inches of charcoal; then the drafts are left well open for about 30 minutes, which makes the fire ready to use. This keeping of the fires during the night not only keeps the coal, but the entire furnace hot, consequently the time saved from heating up the furnaces more than pays for the fuel used.

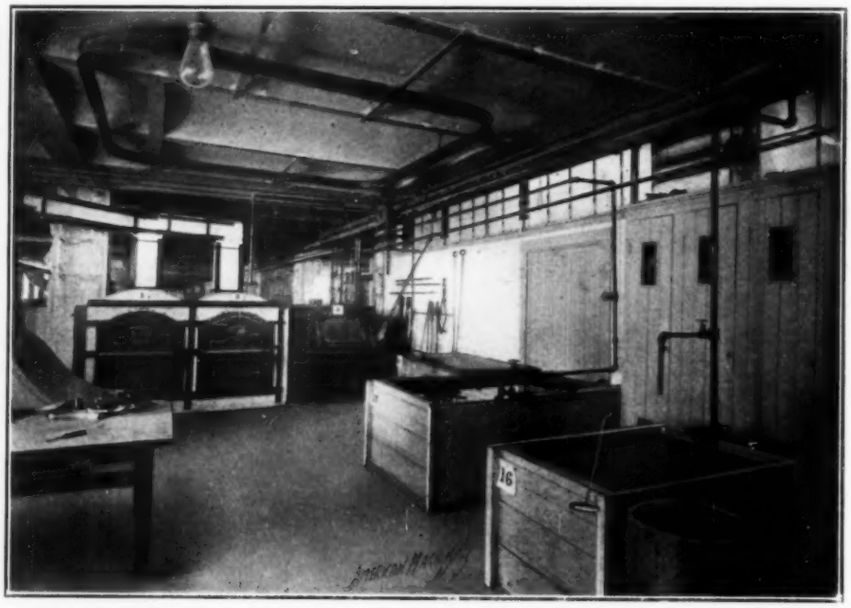


FIG. 1. LARGE COAL AND GAS FIRED FURNACES WITH QUENCHING TANKS

In starting the fires, which occurs once a year, we build them one morning and they are ready for use the next. Of course, they can be used in the afternoon of the same day by crowding them, but it requires more fuel and time to do this than it would to allow them to run until the next day.

OPERATING THE FURNACES

The furnaces Nos. 1 and 2 are built for heating drop-hammer dies and have a heating chamber 38x50 inches. I have heated and hardened one-hundred 4x4x6-inch dies, in a day, by firing the furnace but once during the day.

As soon as the charcoal is heated up it is leveled and covered with plates of common steel ¼x5 inches, placing them about 1 inch apart. These are allowed to heat up to a red heat then the furnace is filled with work and by eleven o'clock the dies will have reached the hardening heat. Up to this time they have not required any attention other than placing them in the fire, the fire heating so evenly that a die 24 inches long can be heated without turning it.

After getting the proper heat on them, the dies are taken from the fire and set in the cooling bath, with about 2 inches of the bottom of the die submerged in the water. It is allowed to remain in this position for a few seconds and then taken out and the high corners as well as the entire face is wiped with a wet cloth to remove any surplus heat that they might contain.

TIME AND FUEL USED

After this the die is placed directly over a stream of water, allowing the face of the die to be submerged about 1 inch. At the same time a few cups of water are thrown upon the back or shank of the die to regulate the contraction which is an important part if the die is to be kept straight. When it has ceased to harden it is moved to one side and left in about 1 inch of water to cool.

After cooling they are polished on the high and flat surface, and placed in what would be termed the ashpit, or directly under the fire, to draw them.

By this time the fire is again filled with dies, which will be heated and ready to harden by 2 o'clock in the afternoon. The four heats, which total 100 dies, have required but six hours of the helper's time to heat and temper them, while it has taken about three hours of the hardener's time for the hardening operations. The fuel used was 40 pounds of charcoal and 300 pounds of anthracite coal.

The dampers of these furnaces are so arranged that the furnace can be fired with the usual amount of coal and the fire kept from three to five days without again firing or adding any fuel. The day before using, the drafts should be opened a few hours before the closing work hour and the fire allowed to burn. Sufficient coal should be added to heat the furnace over night. These are not expensive furnaces to run, even though they are used only twice a week, as the fire can be shut off and started up again with a small consumption of fuel.

Quenching Tanks

The large tank No. 17, shown in Fig. 1, is especially arranged for hardening the above dies. It is 6 feet long, 4 feet wide and 2 feet 4 inches high. There is a 4-inch overflow pipe in one corner which prevents the water from raising more than 26 inches in the tank.

A crate, or number of bars, are placed inside the tank (except at one end) 24 inches from the bottom, to rest the dies on when cooling. This permits a die to set in 2 inches of water when it is so desired.

At the bottom of the tank a T is placed in the 4-inch overflow pipe, running to a convenient corner of the tank. Here is placed a 4-inch angle valve, with the handle extended 2 inches above the top of the tank. This is very important as the depth of the water carried in the tank is regulated by this valve.

There is a 2-inch water-supply pipe leading to the tank, where it is reduced to, or branched off to, 1-inch pipes, each pipe being supplied with a valve. Just ahead of the valve there is placed a 1-inch T, and in this T is placed a 1-inch steam pipe. This must be arranged so that the force of the stream will be in the direction of the outlet of the water, thus adding to the pressure of the water.

The steam is used to remove the chill from the water, as the liability of losing a die is much less with water with the chill removed. When we have only six to eight small dies to harden we do not use the water pressure at all, as the steam is all that is required to harden them properly. On first thought one would think that the impression in the die would sink when used after hardening with steam, but very satisfactory results are obtained from our dies. Furnace No. 3 is a gas-fire furnace with the heating chamber 12x24x60 inches.

A track is shown fastened to the ceiling in Fig. 1, that runs over the tanks to the furnace and annealing box. From this track is hung a ½-ton chain hoist, and with the tongs shown in Fig. 2 a die weighing 800 pounds can be handled by two men with perfect ease.

While these tongs require the drilling of holes in the ends of the die, the holes are very convenient for handling the large blocks in the grinding and forge depot.

Crude-oil Lead-bath Furnace

In Fig. 3 is shown three crude-oil furnaces, which were the second installation that was made in order to make the hardening room a modern one.

The furnace marked 4 is a lead bath 8 inches in diameter and 24 inches deep. This is used for long cylindrical pieces, but the profile cutters or end mills, shown in the tongs on top of the furnace, are also heated in this bath for hardening. This makes the hardening and tempering cost but one mill for each cutter, which is a big saving over the old forge fire or even the gas furnace.

There is considerable opposition to the lead bath which has absolutely no justified

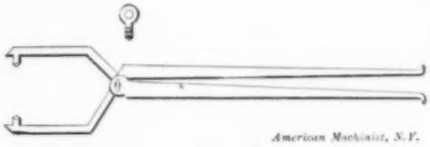


FIG. 2. SPECIAL TONGS FOR HANDLING DIE BLOCKS

cause for some claim that it heats the work too quickly; others that it injures the steel; while others say that the metal should first be preheated; and another objection raised is that the lead adheres to the work.

When tools are hardened they are not usually ready to go to the tool room until they have had some cleaning, and some hardeners clean their work with emery cloth, which requires considerable time. We, however, use a rotary wire brush, which removes any lead or scales, and requires but very little time to put the work in a fair condition to go to the tool or grinding department.

We also keep a bucket of strong salt water near the lead bath, and when we do not want to do any cleaning on the tool after hardening we dip it in this brine, after first heating it to a blue color in the lead. Then by passing it in and out of the brine quickly it is completely coated with the salt and this prevents the lead from sticking when heating the tool for hardening.

There is also a paste that prevents lead from sticking, which can be made of the following materials: One gallon of water, 3 pounds of wheat flour, 1 pound of common salt, and ¼ pound of glue.

In my experience, which covers a period of 20 years, I have not been able to discover any good reason why steel should not be heated in lead, and I have found many reasons why it should be. The most prominent of them all is that a perfectly uniform heat can be given the pieces heated in lead and this is almost impossible to do with any of the regular furnaces for heating tools.

The second reason is that the operator is in a position to handle his work easily In order to do this it is necessary to have tongs and plenty of them. A dozen pairs of well made tongs will soon pay for themselves in reducing the cost of the work as well as the quality produced.

Oil-tempering Furnace

The furnace marked 5 in Fig. 3 is an oil-tempering bath that is heated with crude oil. This fire is a great convenience over the old method of drawing by color, as no man can hope to equal the thermometer in drawing the temper of one piece, let alone numerous pieces.

There are many things to be learned about the operating of an oil-tempering fire, as this fire sometimes proves very expensive. We have found that a good grade of winter-strained lard oil is a good, if not the best, oil to use. It usually ignites, at flashlight test, at about 652 degrees Fahrenheit. This, of course, is considerable more heat than is usually required, yet it will sometimes get beyond control if not closely watched.

Where an oil-tempering fire is heated with crude oil (a tempering fire should be heated by gas, as this is much easier to regulate) the vat or oil-tempering pot should be filled so that one-twelfth of its capacity will be allowed for the expansion of the oil.

There should also be provision made for the boiling over of the oil. This can be done by running 2½-inch pipe out of the side of the pot so that the hot oil can be let out into an iron box securely covered. If the hardening room is on the ground floor, a small pit can be made, which should be well covered.

Operating the Oil-tempering Bath

Care should be used in placing work in the oil with any amount of water adhering to it, or in the holes, especially if it is placed well down in the oil very suddenly. If the oil is very hot this will cause it to boil over. Care must be taken not to add any new oil to the oil already in use, as it will invariably all boil out of the pot when heated. There should also be provision for carrying away the fumes from the oil.

In order to be on the safe side it is well to have the hood built so that it can be closed up and the oil allowed to burn if it becomes ignited. While, of course, this ought not to happen, yet I have seen what might have been a serious fire, prevented by having the hood made so it would withstand a good fire, for it usually is a good fire when it gets started.

The oil collects on the sides of the hood, thus the fire is from the furnace pot to the

outlet of the flue. With proper care and the observance of the above rules, no serious results ought to happen, and the danger of fire should not prevent the installing of the oil bath. I have enumerated them to show the necessity of making such provisions.

Furnace used for Straightening

The oil-tempering furnace is also used for straightening all work. We often hear of some particular way of keeping work straight by dipping it at an angle in whirling water, and again by standing the tool on end and striking it a sharp blow, as well as a great many other ways. No matter what method is used, however, we are not able to produce a day's work without doing some straightening.

There is on most of our tools an allowance of 0.01 inch for grinding, and while this is considerable, it is necessary that all tools be straight, within 0.004 inch and we have a great many to harden that must be within 0.002 inch of straight.

After observing the results of years of experience we have given up hope of bringing some kinds of tools out of the hardening bath straight. I have taken rifle drills 5 inches long, as shown in Fig. 4, and after using the same heat on all of them, as well as cooling them at a uniform temperature, we found them to be in the following condition after hardening:

12 were warped from 0.001 to 0.002 inch
36 were warped from 0.002 to 0.003 inch
25 were warped from 0.003 to 0.007 inch
27 were warped from 0.007 to 0.012 inch
26 were warped from 0.012 to 0.017 inch
17 were warped from 0.017 to 0.022 inch
11 were warped from 0.002 to 0.030 inch

Rules for Straightening Work

It is our experience that hardened work straightens or takes a set in the grain at a heat ranging from 350 to 395 degrees Fahrenheit. At this heat there is no danger of drawing the tool.

It will require considerable experience to learn just the proper amount of strain to place on the tool, with the straightening clamp, and the loss will amount to considerable, unless great care is used in learning to straighten. It will also be found very difficult to straighten a piece that is soft enough to be filed when it comes from the hardening bath, and a soft tool can be detected the first trial by an experienced workman.

The loss in straightening is not worthy of any consideration, as we lose only about one piece out of every 500. It should be remembered that most all of our work is within 0.003 inch of being straight, or 0.0015 inch off of center, when it leaves the hardening department to be ground.

The rifle drills, shown in Fig. 4, require very close work. They are not accepted for grinding if they are more than 0.003 inch out, or 0.0015 inch out of center.

The fire numbered 6, at the back of Fig. 3, is especially arranged for hardening files.

Barium-chloride Furnace

The third installation that was made to improve the hardening, is shown in Fig. 5. This comprises 5 high-speed furnaces and two furnaces for carbon steel.

Furnace No. 7 is a barium-chloride furnace that is built on the plan of the one illustrated on page 18, Vol. 32, of the American Machinist. The entire furnace was built and connected up at a cost of $50. For the bottom we used the base of a heating stove even to the legs, while for the sides we used a 26-inch pulley pattern from which we cast a ring or cylinder.

We then used some of our brass foundry cupola bricks, which just fit this circle, for completing the side walls. This required but 24 bricks. We used a square tile for the top by cutting it to the circle of the furnace and then cutting a hole in the center to admit the top of a No. 60 crucible and leave ⅛ of an inch clearance around it.

We have not, as yet, been able to heat high-speed tools in barium chloride and make them equal the tools hardened in a properly constructed gas furnace, as we cannot get the desired high temperatures without pitting or blistering the steel.

Dies, Reamers, Taps, etc.

On embossing dies, where great pressure is applied, we are now able to convince the engraver that high-speed steel can be annealed so as to permit him to work it, and by not raising the heat of the barium chloride to more than 1925 degrees Fahrenheit when hardening them, the die can be returned to him in as perfect condition as when it left him.

Dies hardened in this way will stand most any pressure that is required of them and the corners hold extremely well. This, however, is not a high enough heat for cutting tools that are put to a working test that causes the tool to heat enough to draw the temper.

Furnace No. 8 is a cylindrical furnace for high-speed steel reamers, taps, etc. This we find a very convenient and profitable furnace, as a reamer or tap can be suspended in it while heating, thus preventing the reamer from bending (not warping).

High-speed steel will stand but little more than its own weight when at a hardening heat; a pointed bar of steel can be forced into it to a considerable depth with the pressure of one hand, thus showing that the steel is very soft when at the hardening heat.

Furnace No. 9 is a carbon-steel furnace used for heating small work, such as saws, etc.

High-temperature Muffle Furnace

Furnace No. 10 is evidently the homeliest of the entire row, costing about $15 to build and set up ready for use, but it has its redeeming qualities. With it we are able to surpass any or all of the other furnaces in the hardening of high-speed steel. It is this design of furnace that enables us to surpass the barium-chloride bath. With it we are able to heat finished tools to 2400 degrees Fahrenheit, without blistering or pitting the metal, or cutting it to pieces with the air.

While, of course, the heats of different steels vary to some extent, there is some steel that requires the extreme heat. I have found it almost impossible to get one grade of high-speed steel, that is manufactured in the United States, as hot as is required for its best hardening, but when given sufficient heat its efficiency is surprising.

Furnace No. 11 is of the same design only larger. This furnace has a heating chamber 14x24x12 inches. We have heated high-speed, form, milling cutters

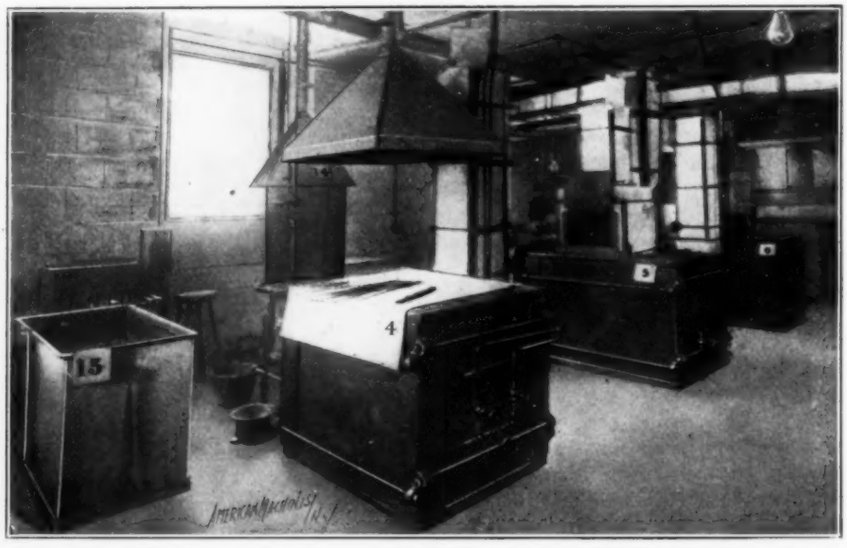


FIG. 3. FURNACES THAT ARE FIRED WITH CRUDE OIL

in it that needed two men for lifting them in and out of the furnace. Before passing the high-speed furnaces I will say that we harden about 5 tons of high-speed steel per year, and that our tools have to equal any that can be had in the market.

In the straightening of high-speed steel we show it little mercy. We take a reamer, or tap, and place it on a block of lead, and by striking on the high places we bend it to its original position.

Annealing High-speed Steel

In the annealing of high-speed steel we find it best to pack anneal where there is a large quantity. We also use lead for annealing high-speed, as well as carbon steel. This method is very satisfactory; in fact, I prefer it to packing in charcoal.

While, of course, the lead must be heated up in order to remove the work, yet the lead shows precisely the heat that the steel has been given, and there is very little waste.

Where a furnace is used entirely for annealing, the lead need not be removed from the furnace. Thus it will be seen that lead annealing will become cheaper than charcoal.

I also found a method of annealing high-speed steel in 40 minutes, which is done as follows: Heat the piece to be annealed to about 1300 degrees Fahrenheit and let it cool in the open air. Then reheat to 1300 degrees and hold it at this point for about 35 minutes. Then let it cool until the red has passed out and quench it in oil. It will be found that the steel will be as easily worked as those annealed by any of the other prolonged methods, and we have not been able to note any injurious effects in the metal from this treatment.

Combination Furnace and Hoods

Furnace No. 12 is a combination high-speed and carbon-steel furnace that is very convenient. With this as with all other furnaces that have come under my observation, the force of the air is not sufficiently broken before it reaches the work, which causes the steel to scale considerably in the heating. We find, however, that steel heated in this furnace is harder

FIG. 4. RIFLE DRILL

than steel heated in furnaces Nos. 10 and 11, but this hard steel will not stand as well as the softer ones. This is very noticeable when the scleroscope is used.

Furnace No. 13 is for carbon steel. We use this for preheating large pieces as well as for heating tools and dies for hardening.

The hoods over the furnaces, as shown in Figs. 3 and 5, add greatly to our health and comfort as well as to that of others working in the building by carrying away the fumes, gases and heat from the furnaces.

The hoods are connected with a 6-inch pipe, leading to a suction fan that has an air suction of from 6 to 8 ounces. This pulls at the fumes, smoke, etc., and takes away nearly all of it. The hood that is placed well up and extends out over all of the furnaces is preferable to the individual hoods.

The cost of production is guarded closely in our shop, and when the reader considers that myself and helper are now handling more tools than were previously handled by seven of us, he will know that it will not take long to pay for the entire equipment, which includes a gas machine for manufacturing gas from gasolene.

The United States Geological Survey is paying increased attention to a line of investigation for the purpose of obtaining more definite knowledge of structural materials, and in view of the increasing importance of clay products as a structural material, and the fact that the Government spends about $40,000,000 annually in construction work, Congress has authorized the prosecution of testing work upon all building products made from clay and used by the Federal Government. It is surprising to note that in 1907 the value of clay products manufactured in this country was $149,000,000. Owing to the growing scarcity of timber and the enormous fire losses of the country a line of investigation such as has thus been instituted is both timely and important, and will, no doubt, develop facts in connection with the subject that will be of considerable value.

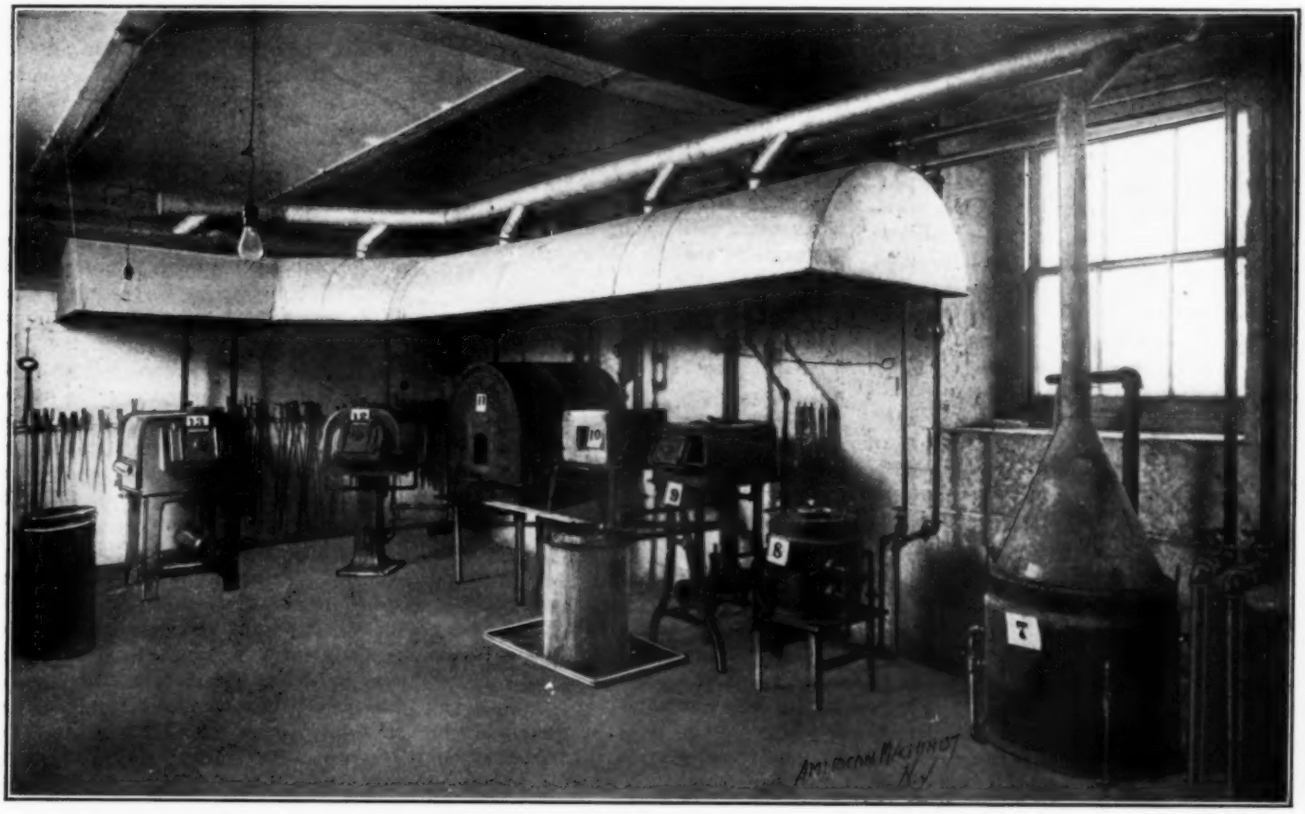


FIG. 5. BARIUM CHLORIDE AND MUFFLE FURNACES, GAS FIRED

Horatio Allen and the Novelty Works

Sketch of the Career of the Man Who Brought the First Locomotive to America and Became the Head of an Immense Engine Industry

BY EDWARD P. BUFFET

It was Horatio Allen who brought the first locomotive to America, who acted as running engineer on the first trip, and who later grew to be of the first magnitude as a builder of marine engines.

To understand how he came to import that locomotive we must look back to the time when the Delaware & Hudson Canal Company was pioneering what has since become a tremendous factor of industry, the transportation of anthracite to tidewater. At this time Horatio Allen was a young civil engineer just beginning to make his mark in life.

From Law to Locomotives

He was born May 10, 1802, in Schenectady, N. Y. His father, Dr. Benjamin Allen, a school principal, gave him a good start on the road of learning and at eighteen the boy graduated from Columbia College with high rank in mathematics. Those were days when none of the doors of a college opened directly upon technological walks of life, so that a young fellow who had been mingling on common footing with the rest of the scholastic herd would have been no more likely to have his attention called to engineering as a vocation than today he would be likely to select the profession of a sandwich man as a logical sequence to taking his degree.

It is therefore not to be wondered at that Horatio Allen at first set about reading law, as his later engine-building contemporary, Charles T. Porter, and many others have done, from lack of reason to the contrary if from no more rational motive. But it took him less time than it did Mr. Porter to discover his real adaptedness and switch off upon the right track. So at about the time he cast his first vote he entered the employment of the Delaware & Hudson company. Afterward he spent a year or two upon the Chesapeake & Delaware canal, but near the close of 1825 he was appointed resident engineer of the summit level of the Delaware & Hudson canal under the eminent John B. Jervis. That brings us to the point where we started, when the company was hauling out its coal by canal and when locomotives did not yet exist on this side of the Atlantic.

In Quest of Knowledge and Engines

The performances of the steam locomotive on the Stockton & Darlington road in England were arousing the interest of American engineers, and in particular of Horatio Allen. Though at an age—twenty-five—when most men rightly feel that they must establish their reputation by steady service with going concerns before cutting loose and offering themselves to the world as technical leaders, Allen threw up his job in order to go to England and acquaint himself with what, he was convinced, would prove the carrying power of the future. But perhaps he already had the situation better in hand than appears, for previous to sailing he received a commission to act as agent for the Delaware & Hudson company, empowering him to procure railroad plates and one or more locomotives for a 16-mile railroad which it was building to connect its mines in Pennsylvania with the canal. One locomotive the company desired as a pattern for construction of additional engines in the United States; as an alternative to which plan it might wish to have them all made in England. The ultimate decision was to procure three there. The company agreed to pay Mr. Allen's passage and expenses, permitting him to remain abroad about three months, the whole not to exceed $900.

Railroad plates of the sort mentioned were primitive rails ½ inch thick by 2½ inches wide at the bottom and 2 inches at the top and 12 to 14 feet long, to be laid on wooden string pieces. It was desired to have the edges rounded if this would not entail too much additional expense. Further, Mr. Allen was asked to report on improvements in coal "wagons," especially as to the size of wheels and manner of connection to the axles. Mr. Jervis wrote him a long letter filled with specifications for his mission.

Visit to Stephenson

Leaving New York in January, 1828, Mr. Allen arrived at Liverpool, where he was cordially received by George Stephenson. The famous trial of the "Rocket," on the Liverpool & Manchester railroad, was not destined to take place until October 14, 1829, in the spring of which year the directors still vacillated between locomotives and fixed engines for the road. The fixed engines would presumably have been used on inclined planes in connection with gravity switchback grades, which arrangement seems to have been a favorite one in the early days of railroading and which still may, or recently could, be seen in operation in the anthracite region of Pennsylvania. Locomotives had, however, been in successful service at Killingworth, Eng., as early as 1814, and there were in use on the Stockton & Darlington railroad locomotives of a common type which the instructions from Mr. Jervis favored. In compliance with the opinions of his chief, Mr. Allen ordered one of this model from Foster, Rastrick & Co., of Stourbridge. It had four coupled wheels, all drivers, two vertical cylinders of 36-inch stroke, placed at the rear of the boiler, "grasshopper" beams, wooden-spoked wheels and cylindrical boiler with several large flues. The blankness of the circular space on the front of the boiler was embellished with a lion's head, whence this engine was dubbed the "Stourbridge Lion."

The "Rocket" and Its Predecessors

While Mr. Allen deferred to the home ideas in ordering one locomotive of this type, he profited by Stephenson's influence sufficiently to contract with that inventor's firm, at Newcastle, for two other engines essentially of what later became celebrated as the "Rocket" type. These, when brought to New York, were stored for awhile in the city, where exhibitions were given with wheels running free of the ground. From this point they are lost to history and it is the "Stourbridge Lion" which is known as the first locomotive on an American railroad. If the "Rocket" type engines had been put into service at once, their trial in America would have antedated the proval of that design in England.

First Locomotive Run in America

The "Stourbridge Lion" was held up during the winter of 1828-29 by the closure of the Delaware & Hudson canal with ice, but reached Honesdale, Penn., in the spring and on the ninth of August, 1829, made its maiden trip on the road from the canal into the Pennsylvania woods where the mines were situated. The engine crossed the Lackawaxen river by a curve on a trestle, where the poorly seasoned timber had brought the rails dangerously out of true. To Mr. Allen fell the honor of acting as engineer and complete crew on this first run, which the numerous spectators believed would necessarily be his last. His last, indeed, it proved, though not because of any catastrophe. Our thrills at his hazard may be abated by reflection that the normal speed of such an engine in service was only 4 to 6 miles an hour, and had it jumped the track at that velocity he might have stepped off upon the ties without losing his cigar. However, he was at the time running without load and may

have speeded up the machine enough to startle the beholders.

More than half a century elapsed before Horatio Allen again visited the scene of his exploit, which occasion was marked with lively emotions at the memories it awakened.

Railroading in South Carolina

The month after his epoch-making run, Mr. Allen became chief engineer of the South Carolina railroad. It was then in question whether to employ horse or locomotive traction there, and his counsel in favor of the latter was unanimously accepted by the directors. As he has stated in his pamphlet, "The Locomotive Era," there was no reason to expect any material improvement in the breed of horses, but in his judgment the man was not living who knew what breed of locomotives the future was to place at command.

By his recommendation the gage of the road was made 5 feet, but a similar suggestion that he later made to the Erie road was rejected, to the great disadvantage of modern heavy railroading. A railroad gage is one of the standards which it seems impossible to change.

Invention of the Swiveling Truck

To Horatio Allen is due a large share, if not the whole credit, of originating the swiveling truck. The light plates on 6x12-inch stringers which then served for rails were incapable of sustaining a heavy weight, the safe load on the Liverpool & Manchester railway being three tons, or even less, per pair of wheels. Hence the limitation of locomotive wheels to four necessitated the use of light engines and entailed correspondingly heavy operating expense in transporting a given quantity of freight. In 1831, Mr. Allen called the attention of the South Carolina railroad directors to this difficulty and recommended the employment of more than four wheels, with swiveling trucks to enable the passage of curves. Consequently he was empowered to place contracts with the West Point Foundry for locomotives built on that principle. The first of these was the "South Carolina," and put in operation early in 1832. A couple of years later a patent was granted to Ross Winans, of Baltimore, for eight-wheeled cars with two trucks. Some such were built or used by the Newcastle & Frenchtown Turnpike and Railroad Company in defiance of Ross' patent claim. This led to twenty years' expensive litigation, virtually involving the interests of all the railroads, and it was not until 1858 that Winans' patent was finally declared invalid. During the dispute recourse was had to evidence that the double-truck principle had been employed before the patent date by Horatio Allen.

The South Carolina railroad locomotives of this type were double-enders, consisting of two engines facing apart and joined by a firebox in the middle. Each boiler was double-barreled and rested on a four-wheeled, jointed, swiveling truck, there being one cylinder to each truck.

John B. Jervis himself was another pioneer in using the truck form of construction and seems to have been at least a close second. The truck idea had, indeed, been foreshadowed as long ago as 1812 in an English patent to William and Edward W. Chapman.

After completion of the South Carolina railroad, Mr. Allen was variously occupied. He married, traveled abroad for two or three years and served as principal assistant engineer of the Croton aqueduct under his old chief, John B. Jervis.

The Novelty Works and the "Novelty"

Horatio Allen's *Lehrjahre* and *Wanderjahre* came to a close in 1844, or thereabouts, when he entered, as one of the proprietors, that famous engineering works in New York City with which his subsequent career is identified. He became a member of the firm of Stillman, Stratton & Allen, owners of the "Novelty Works."

About the early part of the thirties, Rev. Dr. Eliphalet Nott, president of Union College, Schenectady, N. Y., who had been active in introducing anthracite for house stoves, invented a steam boiler to run on that fuel and decided to build a steamboat in which to make a test. Besides burning this novel fuel, he proposed to install a novel mechanical equipment throughout, wherefore the boat was called the "Novelty." This name attached itself to a shop which he established to do repair work, etc., on the vessel. It consisted of a wharf and some buildings situated in New York City, on Burnt Mill point, so-called, at the foot of Twelfth street, East river. The "Novelty" herself ran from New York to Harlem. The Novelty Works gradually extended its attention to outside business, and from an equipment of a few tools in a little shed, grew to be the biggest marine-engine building establishment in the country.

Development of the Works

In the early days the business was conducted by Nott & Co., under superintendence of N. Bliss, formerly of the West, the foreman being Ezra K. Dodd, who afterward was made chief engineer of the "Novelty." Later Thomas B. Stillman took charge of the plant and, in 1838, it passed into the hands of a firm including himself, John D. Ward, Robert M. Stratton and C. St. John Seymour. Messrs. Ward and Stillman were the mechanical men of the firm. Among the work turned out were two ocean steamers, the "Lion," and "Eagle," for the Spanish government. Mr. Ward retired from the firm in 1841 and Mr. Seymour not long afterward, Mr. Allen being admitted about 1844. Eventually he secured practical control of the enterprise with the financial aid of Brown Brothers, bankers, Mr. Stillman retiring.

In 1855 the concern was chartered as a corporation with $300,000 cash capital, the corporate title, "Novelty Iron Works, of New York," expressing what had from the beginning been its popular designation. Horatio Allen became its president and dominating spirit.

A Great Old-time Engine Shop

It may be of interest to summarize an account of the Novelty Works given about the time of the war, in order to estimate how progress in similar plants has been made between that period and the era of West Allis and East Pittsburg.

Near the entrance gate, with its porter's lodge and offices, was a large crane for handling shafts, cylinders, boilers, vacuum pans and other ponderous pieces of machinery. To the left was the iron foundry, 206x80 feet, with a wing. It contained four cupola furnaces capable of melting at one heat 65 tons of iron, which could be cast into one mold. There was also another furnace. The foundry blast was led through an underground pipe of 5 square feet sectional area. Some of the foundry cranes were as strong as 20 tons load. Here were made the bedplates for the steamship "Atlantic," weighing 37 tons, and for the "Arctic," 60 tons. In the summer of 1854 there was cast the cylinder of the steamer "Metropolis," of the Fall River line, having a diameter of 105 inches and a length of 14 feet, with 12 feet stroke of piston. Twenty-two people sat down to lunch in the cylinder, with room to spare, and a horse and chaise were driven through it.

The smiths' shop was equipped with thirty forges, hammers and some cranes of large capacity, evidently of gib type, In one case a piece of iron weighing 14,366 pounds had been forged and handled. There were also machine and finishing shops, two boiler shops, etc., each with its appropriate machinery.

The whole establishment was divided into twenty departments, each having its foreman, viz.:

Iron founders, brass founders, machinists, boilermakers, carpenters, coppersmiths, blacksmiths, metallic lifeboat builders, instrument makers, hose and belt makers, painters, masons, riggers, laborers, cartmen, watchmen, storekeepers, patternmakers, draftsmen and clerks. All told, an average number of more than 1000 men were employed, and the work turned out amounted to some $1,330,000 a year. At one time over 1500 men were employed and owing to the scarcity of labor Mr. Allen went to Europe to obtain hands. The works occupied nearly two blocks and included two slips sufficient in size for the largest steam vessels. Machinery for many of the old Collins line and Pacific Mail steamships was built there. In addition to marine work the company turned out a varied line of me-

chanical products, such as stationary engines, pumps, sugar machinery, steam fire engines, and hydraulic presses.

Allen's Engineering Faith and Practice

Horatio Allen was a firm believer in oscillating-cylinder engines as compared with beam engines for sidewheelers. He wrote a pamphlet, 1867, claiming for them superiority in compactness, lightness, simplicity and application of power. An "objective point" (to borrow a term from a certain Mrs. Malaprop of our acquaintance) seems to have resided in the valve mechanism. An experimental valve gear which Mr. Allen applied to the engines of the "Adriatic" caused so much trouble that it had to be taken out. It employed large conical-plug valves with a device for lifting them to be turned, so as to prevent their jamming. It would probably be indulging in unwarrantable panegyric to describe Mr. Allen as a great inventor. But he believed in himself and he disbelieved in Sickels, of whom he considered himself a standing rival, and whose cutoff, C. T. Porter says, he would never allow to be applied at the Novelty Iron Works. The same authority tells us, however, that Mr. Allen, in his later years, when judging at the Centennial, united in an award to Sickels with an expression of cordial admiration.

At the time of the war the Novelty works built engines for several vessels of the Federal navy, including the double-turreted monitor "Miantonomah."

From this period dated a long controversy in the navy upon the economy in using steam expansively. Chief B. F. Isherwood, of the Bureau of Steam Engineering, and others, advocated moderate pressures with moderate ratios of expansion, while their opponents, including E. N. Dickerson, advised high pressures and high expansive ratios. The dispute became so animated that a commission was formed under Government auspices to make tests and, if possible, answer the question. These experiments were carried on at the Novelty works, largely under direction of Mr. Allen, who was of the high-expansion party, but who suspended judgment during the trials.

These investigations lasted so many years that the world grew weary of waiting for the results and the Government tired of paying for them. It seems that the points at issue were not all clearly settled and the results did not go to vindicate the extreme claims of either party. The data collected tend to show that with increased pressure the economical point of cutoff shortens, but that with any pressure the most economical degree of expansion is soon reached and further expansion rapidly grows wasteful.

Subsequently Commodore Isherwood and Mr. Dickerson arranged a series of comparative tests of the "Winooski" with Stevens cutoff and double poppet valve, 60 pounds pressure and cutting off at sixtenths of stroke, against the "Algonquin," with Sickels cutoff and single poppet valves, 90 pounds pressure and cutting off at one-tenth stroke. The "Algonquin" failed.

The Closing Years

Engineering work flourished during the war and the Novelty works were kept very busy. But their profits were not correspondingly large. The cost of labor and materials was constantly advancing, and since the machinery built was of a sort that often required a considerable time to complete, the tendency was for expenses to exceed the estimates underlying contracts. In late years business slackened. Meanwhile the equipment was growing old and the real estate occupied by the plant had become very valuable. All things considered, it seemed wise to wind up the business, and about 1870 this historic establishment passed out of existence.

Mr. Allen survived the works a score of year. His death occurred within a few hours of the close of the ninth decade of the century, at his home near South Orange, N. J.

Horatio Allen made a variety of inventions, from 1841 to 1879, those among them relating to steam cutoffs and valve gears standing out conspicuously. Toward the close of his life he interested himself in methods of teaching astronomy and constructed a number of instruments for the purpose. He was the author of an elementary book on arithmetic.

During his connection with the Novelty works his eminence in his profession was recognized by a number of outside appointments. Thus, he was made consulting engineer for the Erie railroad, the Panama railroad and of the Brooklyn bridge. He also served a term as president of the Erie.

Horatio Allen has been marked by his contemporaries both with criticism and with praise. A tendency to dissent from some of his opinions is manifest in the "Engineering Reminiscences" of Charles T. Porter, who, among other disparaging remarks, animadverts upon Mr. Allen's tiresome fussiness as president of a group of judges at the Centennial.

On the other hand, he is spoken of with high encomium by his old friend, M. N. Forney, who upon his death published in the *Railroad and Engineering Journal*, which Mr. Forney was then editing, and afterward in pamphlet form, a biography with some interesting old documents relating to his early locomotive experience. Mr. Forney describes him as a man of broad tastes and interests, gentle and appreciative in his integrity. He was strong in his indignation toward such methods of business bribery as have become common in our days of the exaggerated dollar.

Special French Lathes for Bar Work

By Joseph G. Horner

Readers who have a little acquaintance with French practice may have noticed illustrations of peculiar types of lathes, which are unlike those made in other countries. The principal feature that strikes one is that the beds or ways are composed of a single steel bar, of rather slender cross-section, and that the slide rest is manipulated by conspicuous wooden handles. Another point is that hardened steel enters largely into the construction of the parts, being in many cases where we would employ cast iron. We take the opportunity of illustrating one of these lathes made by MM. Brenot, Buronfosse

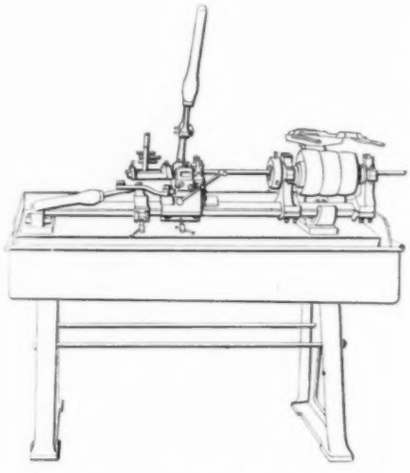


FIG. 1. A FRENCH LATHE FOR BAR WORK

& Cie., of Paris. It takes bars up to 25 mm. diameter, and of any length.

The general appearance of the lathe is seen in Fig. 1, and we take first the detail drawings of the carriage, Figs. 2, 3 and 4. The two bars (instead of one) *A*, the larger, and *B*, the smaller, may be seen in these views. *A* is 40 mm. across the flats, and *B* 27 mm., and they are set so that the chips slide off. At two places they rest in sockets, one at the outer end, and one under the headstock (see Fig. 1), these sockets being ground out when placed side by side, to insure parallelism of the bars. The bottom portion of the carriage *C* fits on the bars, and is held with caps, *D* and *E*, of brass, which are removed and filed on the joint lines when necessary through wear. On *C* a cross-slide *F* moves, slack being taken up by the adjustable piece *G*; *H* is a handle turning a quick-pitch screw which effects the motion of the slide *F* either backward or forward. There is a tool on each side, gripped in the holders *J J*, while a third tool, generally used for cutting off, is secured in the slot at *K*. This slot is formed in the long lever, which has a

tapered end to hold the wooden handle seen in Fig. 1, and at the back is pivoted on pointed set screws in a bearing *L*, adjustable to and fro by the screw *M*, and up and down by another *N*, clamping screws being provided, as shown. The point of the cutting-off tool held in *K* can thus be adjusted with precision, and there is a stop screw at *O* to determine its downward movement. *O* comes to rest on a boss, extended up from the portion *C*, and in this boss a bush is inserted and secured with two set screws. The hole in the bush is of suitable size to let the stock bar run in it, so that it is perfectly steadied while the tools are at work.

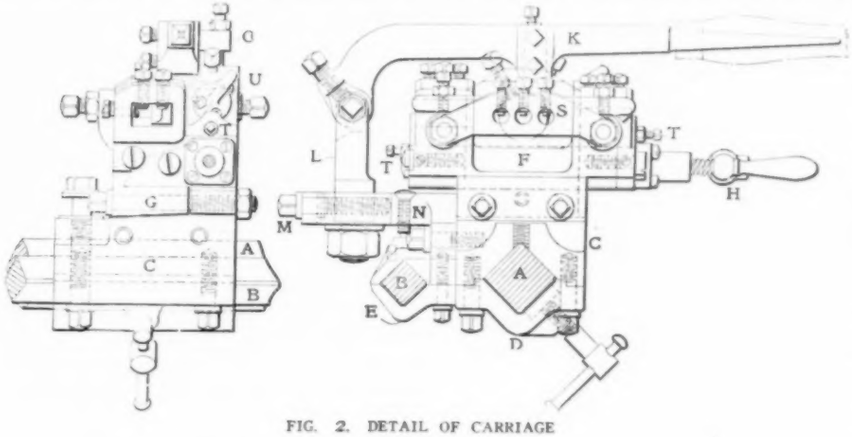


FIG. 2. DETAIL OF CARRIAGE

On looking at Figs. 3 and 4 a bracket *P* is seen, secured to the bar *A*, and having a long lever *Q*, Fig. 4, also pointed for a wooden handle, pivoted on it, and coupled to a connecting rod *R*, pivoted to the slide *C*. If *P* is fixed, and the handle *Q* worked to and fro the slide *C* partakes of the same motion, so that the tools in the holders *J J* operate on the work, first one and the other tool being brought up by turning the handle *H*. After the turning is finished the cutting-off tool is pulled down to sever the piece. The stock is not moved through the chuck, but the rest is made to follow it up as the material gets shorter with successive removal of pieces. At the commencement the bar stands out to the length of the bed, and as it is always steadied in the bush already mentioned the amount of overhang is of no consequence.

To determine the length of stroke of the rest, three stops are incorporated in the form of plain, round rods, set in holes in one of three cross-bars *S S S*, whichever happens to suit the length of traverse required. The two bars nearest the rest can be slewed up out of the way, leaving the back bar exposed. The stop rods come to rest against the end of the stock bar, forming a positive dead check which insures all the pieces being of uniform length. The length of travel of the slide *F* in each direction is determined by an arrangement as follows: On each side of the slide *F*, above the operating screw, is a little set screw *T* provided with a lock nut, and the metal is carried up above this in the form of a curved ear; on the fixed part of the rest, at each side of the central boss, is a small turret *U* pivoted and supplied with a locking device. The turret is turned into any of its three positions by means of the short upstanding handle; two set screws are tapped into the turret and fitted with nuts, so that, like *T T*, they can be adjusted. Now, if the turret is set with the handle pointing perpendicularly neither of the set screws will come into action, but the one *T* on the slide will abut against the solid face of the boss. But if the turret is revolved in either direction, one or other of the set screws in it will come opposite the ear above *T* and arrest the slide. This gives three stop distances, available either for roughing, or for producing different diameters. These turret stops are a patented feature of the lathes, giving them an advantage for complicated work over those with a single stop only. All the parts of the rest are made of hardened and ground steel, no cast iron being used.

Fig. 5 shows a sectional elevation and end view of the headstock. The hollow mandrel *A* revolves in capped bearings, and has a chuck *B* with two dies, closed by set screws; the collar *C* is secured with two screws, and serves to receive the two other screws (not seen), which close in the dies. The washers at *D* receive the end thrust of the spindle. The spindle carries three belt pulleys, one fixed *E*, with two loose, *F* and *G*. *F* is driven with a crossed belt from the counter, and *G* with an open belt from a larger pulley. When the belt is moved from *G* onto the fast pulley the latter runs at a high speed suitable for turning, but when the belt from *F* is shipped over, the spindle runs backward and slowly for threading. To run the threading tackle off the work the high forward speed is thrown in. By

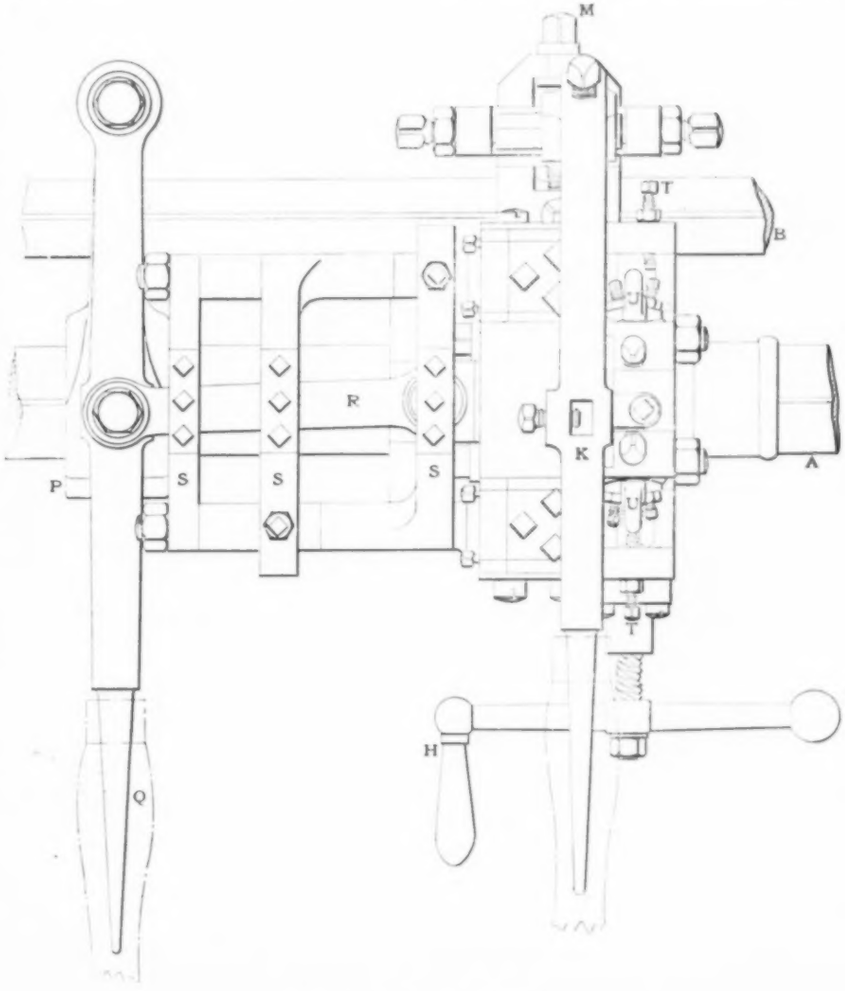


FIG. 4. PLAN OF CARRIAGE

means of the belt-shifting gear, shown in Fig. 1, the belts can be manipulated with facility.

The entire lathe is mounted on cast-iron legs, with galvanized-iron tray to catch the cuttings and lubricant. The tray is backed with wood to absorb vibration.

A taper-turning attachment is fitted to these lathes when desired, a steel bar being utilized to move the cross-slide. A self-acting feed motion to the slide is also given to the lathes if wanted; a screw at the front of the bed is rotated by gears from the headstock and works in a form of clasp nut which is connected to the operating lever, thus moving the rest automatically for heavy work. Only the larger

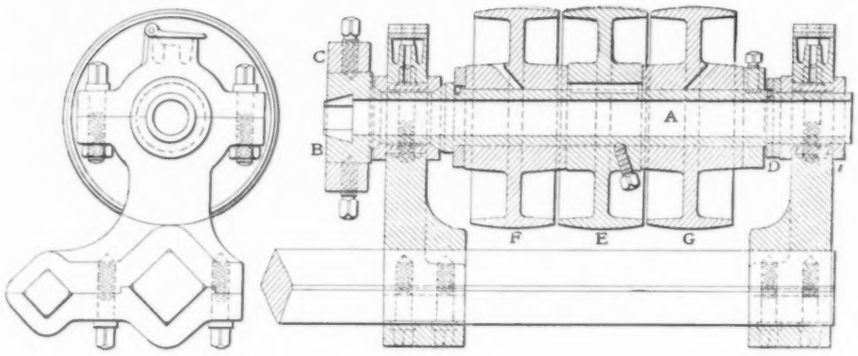


FIG. 5. END VIEW AND SECTION OF HEAD

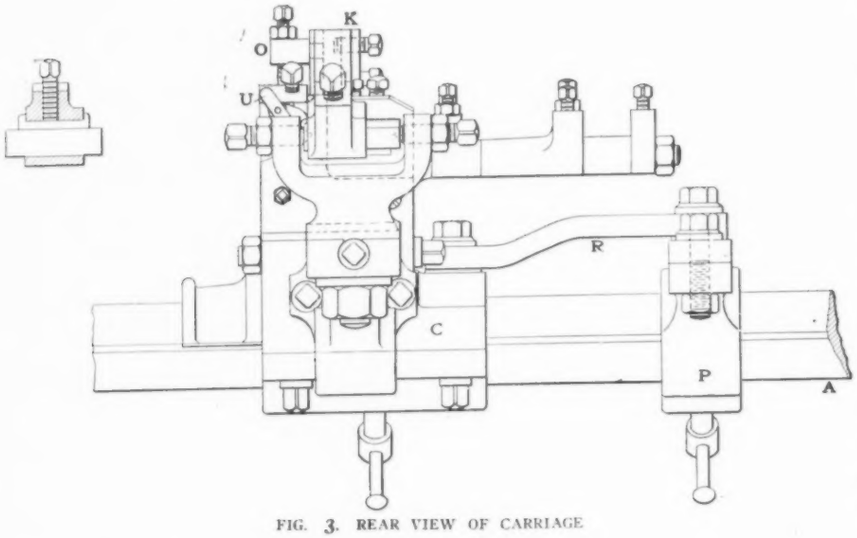


FIG. 3. REAR VIEW OF CARRIAGE

pulleys similar to the first lathe described.

[One peculiarity about this lathe which strikes us more than any of the others is that it is *left*-handed.—Ed.]

For the skill and intelligence exhibited in developing ingenious mechanisms in connection with presses for the extraction of liquids from various substances, which comprise devices for automatically feeding the presses, automatic cleaning of the remains of the substances pressed, regulating the pressure required and varying and regulating the time during which the pressure exists, and for sustaining the maximum pressure for any desired period, the Franklin Institute has recommended the award of the *John Scott Legacy Medal and Premium* to Homer A. Herr.

sizes, of 50- and 60-mm. stock capacity are so provided.

Fig. 6 shows a special drilling rest which is fitted to a type of lathe resembling the previous one, but employed only for drilling. This rest is clamped on the two bars (both of the same size, 28 mm. across the flats) of the bed by a cap *A* secured with four set screws passing through the bottom part of the rest *B*. The latter receives a spigot *C*, carrying the slide *D*, and there is another spigot at *E*, also fitting in the piece *B*. By turning the screw *F* the slide *D* can be raised or lowered to bring the work to be drilled into exact position. Cross-adjustment is provided for by the slide *G* and longitudinal traverse for the working stroke by the slide *H*, reciprocated with the handle *J*, and arrested by the stop screw *K*. If the work demands it, the slides may be thrown at an angle through the radial slot at *L*, and secured with the screw *M*. *N* is used to locate the slide *D* when set straight by means of a taper hole into which *N* fits. On the front end of the slide *H* several tapped holes are located for the purpose of receiving set screws to grip chucks and other fittings for holding the work. Sometimes the work is held in the mandrel chuck, and the drill on the slide *H*. The mandrel has fast and loose

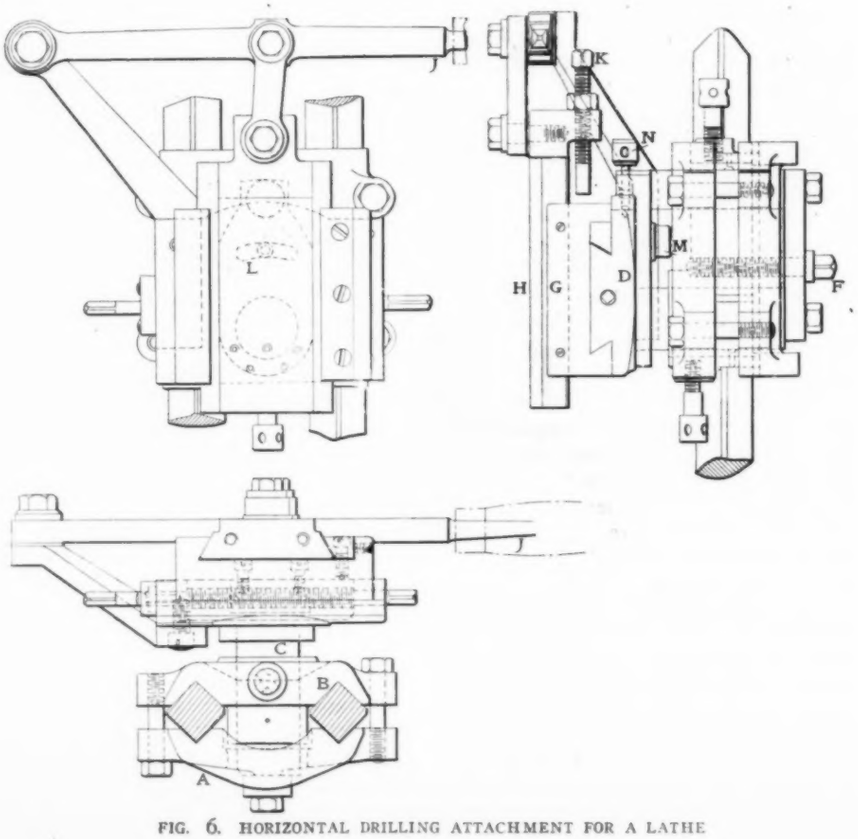


FIG. 6. HORIZONTAL DRILLING ATTACHMENT FOR A LATHE

Milling Small Parts with Special Cutters and Fixtures

By John W. Breads

In the production of small interchangeable parts for typewriters, sewing machines, adding machines, etc., where accuracy and quantity are required at a minimum cost, and where only milled pieces will answer, a number of fixtures, more or less expensive, embracing a series of operations leading up to the finished product are required.

The accompanying sketches show the various milling and drilling operations required to produce successfully the little "link connection" shown right- and left-hand in Fig. 1.

In Fig. 2 we have a milling fixture in which the first and second cuts are taken from the rough stock, which for this piece measures 13/32 inch thick by 1 5/16 inches wide. The fixture contains many good features, and has been used to such good advantage in our factory that a short description may not be amiss. The fixture, an end view of which is shown in Fig. 2, consists of a cast-iron base *A* which is 24 inches long. This base carries four clamps *B*, two on each side, that run the whole length. These clamps are made of machinery steel and faced with the hardened tool-steel pieces *C*. The hardened tool-steel pieces *D*, *E* and *U* are also fitted as shown; *D* on the one side, flat, to receive the rough stock for the first cut, and *E* on the other side made to the form produced by the first cutter and upon which the second cut is made. The piece when milled has the shape the whole length shown at *F*. As stated before, the fixture has four clamps, two on each side, 12 inches long; we have found this of advantage as it enables us to machine stock in 12-inch lengths, four pieces being held in the fixture at the same time. One advantage in this is that rough stock which comes in lengths varying from 12 to 14 feet is usually very winding, and a piece 24 inches long would be difficult to straighten or to clamp evenly in the fixture.

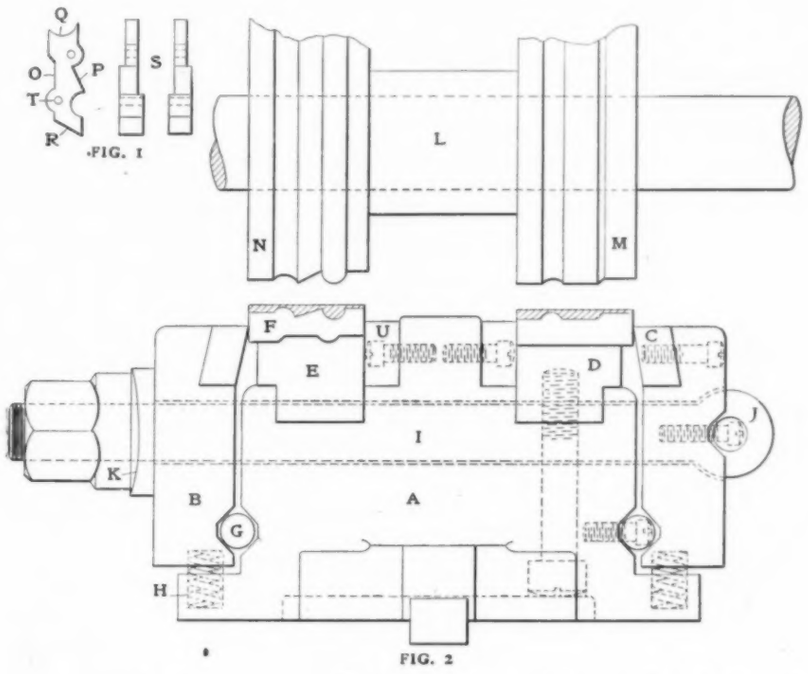


FIG. 1

FIG. 2

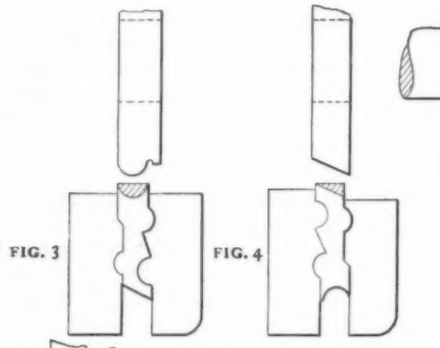


FIG. 3

FIG. 4

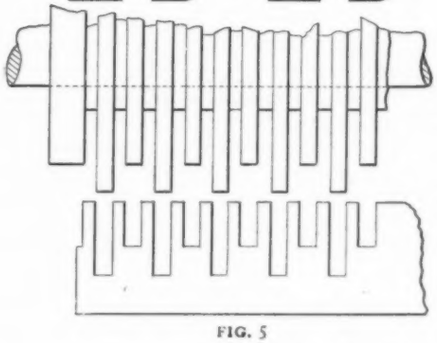


FIG. 5

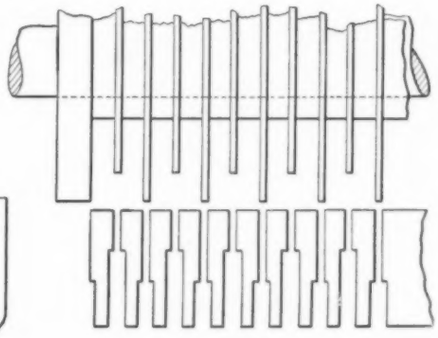


FIG. 6

MILLING FIXTURES AND CUTTERS

Referring to Fig. 2, it will be seen that clamps *B* swing on a V cut their entire length and resting on a rod *G* which also extends the whole length of the fixture. The rod is fastened to the base by means of screws. The springs *H*, of which there are a number under each clamp, tend to force the clamps up when the draw bolts *I* are loosened, so that only the bottom side of the V is against the rod *G*. When the stock is placed in both sides of the fixture, and the clamps are ready to be drawn up by means of bolts *I*, of which there are six, three in each clamp, the clamps being forced up against the lower side of the V and away from the top of the V their first action is to tip forward against the stock and clamp it. They are now tight against the stock and the lower side of the V in the clamp and any extra pressure put upon them by the bolts *I* must necessarily have a tendency to force the clamp down until the V's are in their natural position on the rods *G*. Thus the work is drawn down firmly to its seat on *D* and *E*. The clamp bolts *I* acting on a pivot at *J* with clearance through the base as indicated by dotted lines, and with the crown-faced nut and concave washer at *K*, allow the clamps ample freedom to adjust themselves to the work. It will readily be seen that this fixture is very strong, both from a point of durability and also as regards holding power, which is very essential where formed cutters are employed.

In the milling of the little connection, Fig. 1, in the fixture, Fig. 2, two formed cutters are used, running on the same arbor with a collar *L* of the proper thickness between. These cutters are formed to correspond with the outline required on the sides of the piece and are of such relative diameters that when cutter *M* is milling one side of the rough stock to correspond to surface *O*, Fig. 1, cutter *N* is forming the opposite side to shape *P*, Fig. 1, thereby bringing the entire length of the strip of stock to the correct thickness and form.

Our next step is to cut these pieces into 6-inch lengths, after which they are, one at a time, placed in a pair of milling jaws, Fig. 3, and the end *Q*, Fig. 1, milled. Next, another pair of jaws, Fig. 4, are used and end *R*, Fig. 1, is milled. The 6-inch lengths are now completely milled to shape, and we have only the clearance cuts and cutting off to consider, which will bring the sides to the shape shown at *S*, Fig. 1. Another pair of milling jaws is here used and a gang of saws, as shown in Fig. 5, is run through to produce what is called the clearance cut. In like manner the cut-off gang, Fig. 6, is used. These gangs are made of a length to cut up the full 6-inch length of strip which in this case gives us nine complete pairs of connections at each cutting-off operation.

They are now placed in a drill jig and holes *T* are drilled which completes the job. The gangs of clearance and cut-off saws and the collars between them must be made very accurately in order to match one another in the different cuts. This method is very rapid and efficient, and we find the pieces can be held within from 0.001 to 0.002 of size in the daily output.

A New Adjustable Facing Tool

By D. Esner

To meet the requirements of a factory having a considerable number of castings to be faced, relatively with the holes there-

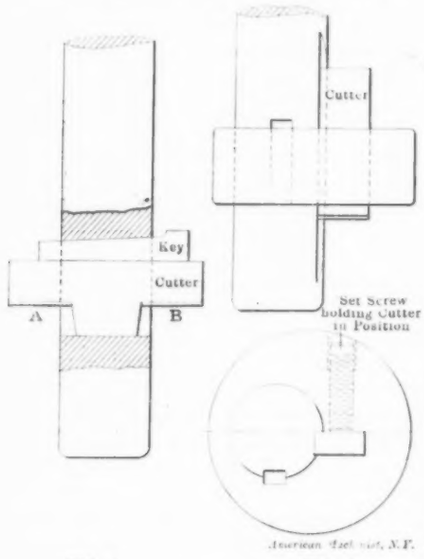


FIG. 1 FIG. 2

COMMON FACING TOOLS

in, a new adjustable facing tool has been designed to combine the advantages of accuracy, rigidity, and adjustability, thus enabling the work to be done with ease on the table of a drill press.

Before describing the new tool it would be as well to refer to older types of facing tools in common use, pointing out the defects in each.

In Fig. 1 is shown the ordinary every-day type of tool used for facing. This consists of a slotted shank in which the cutter is inserted and wedged securely by means of a tapered key. The cutter bar would be the same diameter as the hole in the casting, or the size of the pilot hole in the stud on which the work was placed. The cutter at *A* and *B* has been nearly half ground away from use, and this brings to light the principal objection to the tool, viz., the difficulty experienced in keeping both edges of the cutter parallel and in line with each other, so that both sides cut equally and truly. It will generally be found on examining this tool in work that one side of the cutter is doing most of the work.

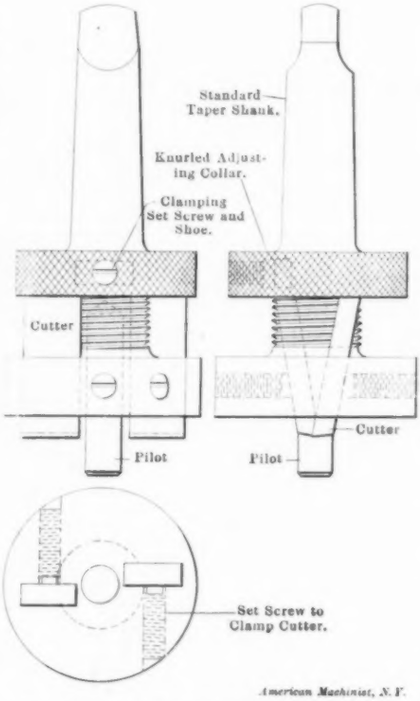


FIG. 3. NEW ADJUSTABLE FACING TOOL

The tool shown in Fig. 2, is also a common type of tool and overcomes some of the objections of the tool shown in Fig. 1. It is, however, not altogether satisfactory as it cuts entirely on one side, and while it starts cutting quickly, having only to get under the scale at one point, instead of at two as in Fig. 1, it requires more care in use to prevent forcing it to the breaking point. The side action is also somewhat liable to wear the hole in the casting out of truth.

In Fig. 3 is shown the new adjustable facing tool which obviates all of the defects of those shown in Figs. 1 and 2. In designing this tool the following points were kept in mind: First, to get a balanced tool with the cutters on each side ground absolutely alike. Second, to provide interchangeable pairs of cutters which could be kept in stock to do away with waiting for sharp cutters. Third, to provide a holder in which the pairs of cutters could be inserted, and which would insure that each cutter did its share of the work, cut parallel and at right angles with the hole, obviated all uneven strains from side cutting, and with proper angles of shear and clearance. (Note. Cutters in tools shown in Figs. 1 and 2 have no shear.) Fourth, to facilitate the putting in and taking out of cutters.

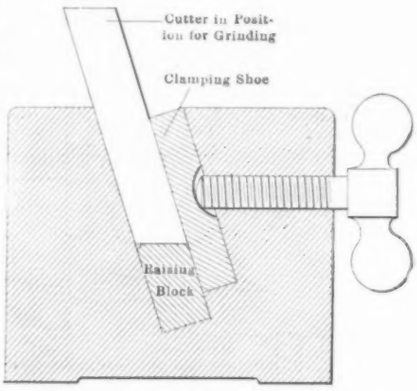


FIG. 4. GRINDING GAGE FOR CUTTERS

To accomplish this it was first necessary to insure that both cutters would be ground alike, and this was done by making a grinding fixture as shown in Fig. 4. This latter is a block of steel with a slot cut in it at the proper angle to hold both cutters while they are being ground. The cutters rest on the bottom of slot and are forced over by a shoe, with the thumb screw, to the back side of the fixture. A block is also provided for this fixture to raise the cutters when, after much grinding, they get too short to rest on the bottom.

The cutter holder as shown in Fig. 3 has a standard taper shank to fit a drill press. The bottom has a hole for a pilot, to steady the work when cutting; this is held in place by a set screw and can be easily taken out and replaced by a pilot of a different diameter. This pilot goes into the hole in the casting, or preferably into a correspondingly sized hole in the stud on which the casting is placed for facing. The bottom end, or flanged part, of the cutter holder is milled through at the proper angle of shear for the cutters, and a collar is shrunk on over the slotted flange. In these slots the cutters are placed and held merely by blind set screws, there being little, if any, strain on them. On the body of the tool above the slotted flange is cut a fine thread sufficiently strong to take the thrust of the cutters. A nurled nut, or collar, a little larger than the outside diameter of both cutters, when inserted in the holder, is screwed on. Against this the cutters rest, so that both cutters, which are ground exactly alike as to length, protrude equally on each side from the slotted flange and, therefore, make a perfectly true and parallel cut. As the cutters wear they are re-

ground in the fixture shown in Fig. 4, replaced in the holder, and the nurled collar turned, until the cutters are advanced far enough to suit the job. The collar is provided with a blind set screw to clamp it against the body of the tool. This set screw acts against a shoe set in the collar, to prevent damaging the thread on the tool body when clamping it. The shoe has length enough to prevent its dropping into the slots for the cutters.

Another advantage this tool has which is worth bringing forward is the saving in high-priced cutting steel, due to the fact that pieces can be used up to within a very short distance of the end. This combination also makes a perfectly rigid, accurate, compact, and economical tool, and so far as our experience has gone has proved itself thoroughly satisfactory in every way.

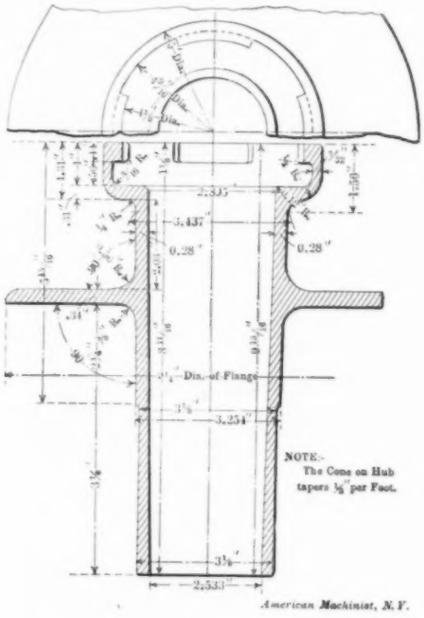


FIG. 1. WHEEL HUB TO BE FORGED

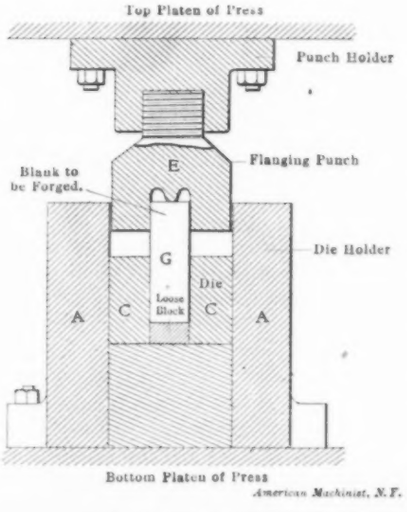


FIG. 2. FIRST OPERATION

Hydraulic Forging

By Bruce Browning

This article is written with the idea that it may bring to many superintendents not familiar with the process, the knowledge that many forgings, now made by hand, which are impossible to make on a drop hammer, can, with a few inexpensive dies, be made on a hydraulic press with a rapidity and consequently with an economy that would startle them.

The proper way to forcibly present evidence for proving the above statement is to furnish an example. Hence we will assume that you have an order for 5000 wheel hubs, to be made as shown by Fig. 1. The hubs are to be made of forged steel and finished all over. Now, what would you do? Would you turn them out of a solid bar 9¼ inches in diameter? No. Would you have them drop-forged? They would be able to drop the flange for you, but on account of the draft necessary in drop forging, excessive machining would be required, and you would either lose money or be underbid by competitors. If you forged them under a steam hammer the same condition applies as for the drop hammer, except that the results are worse.

Show your sketch to a person familiar

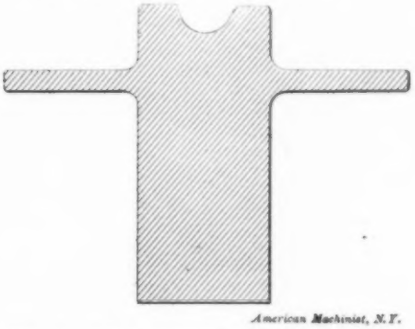


FIG. 3. CROSS SECTION OF FORGING AFTER FIRST OPERATION

with hydraulic forging, and he will immediately tell you that he can forge the piece, hole included, leaving about ⅛ inch stock for finish. Below is a description of the method and dies he will use.

First, he will figure the approximate weight of the piece as a rough forging, allowing whatever is required in the shop for machining. A piece of stock 3½ inches in diameter is cut to a length so that the blank is slightly heavier than the rough forging.

In Fig. 2 a cross-section is shown that shows the dies with the blank *G* in position, ready for the first operation in forging. You will understand that all the operations are accomplished through the pieces being heated to a good forging heat. The press should be of about 150 tons capacity, with a quick stroke and a good sized pullback.

The cross-section of the forging after the first operation is seen in Fig. 3. You will notice that the flange is complete. On the top is a small indentation made by the flanging punch *E*. This is to help guide the punch in the second operation as seen in Fig. 4. The die *C* stays in the die holder *A*, while the two half dies *D* and *B* are removed with each forging after it is punched. This is necessitated by the shoulder of the complete forging as seen in Fig. 5. In punching the forging is placed in the die *C*, then the half dies are placed on top, as shown, and the press is operated.

The cost of labor is very small per forging, as a pressman and two helpers will easily turn out 100 finished forgings in 10 hours. The dies are very simple when compared with drop-forging dies, as they can be finished on a lathe and require little or no expensive hand work.

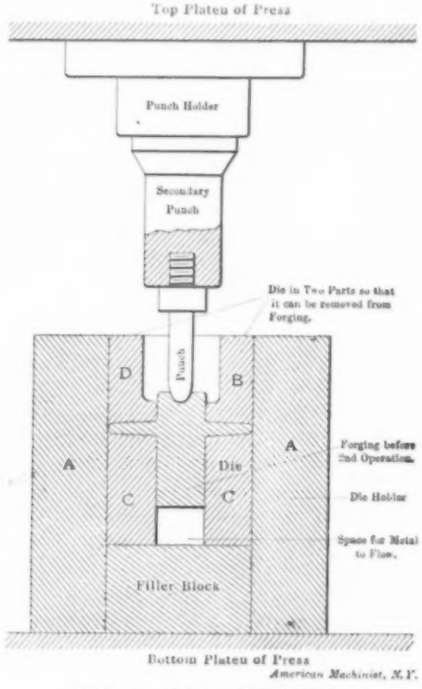


FIG. 4. SECOND OPERATION

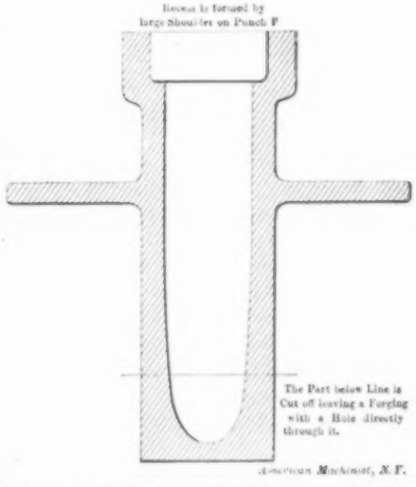

Recess is formed by large Shoulder on Punch F
The Part below Line is Cut off leaving a Forging with a Hole directly through it.
American Machinist, N.Y.

FIG. 5. FORGING AFTER SECOND OPERATION, READY FOR MACHINE SHOP

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Demagnetizing a Watch

I had my watch demagnetized recently in a way which was, to me, both interesting and novel. I had taken a new position and spent the first week in wandering through the shops getting familiar with things before settling down to routine work. After the first few days I was much annoyed to find that my watch had "gone wrong;" it did not stop altogether, but went in fits and starts to suit itself, and as electric power was used throughout the works, I put two and two together and came to the conclusion that I had been getting into undesirably close proximity to some of the many motors or the generating station and so got my watch magnetized.

It is rather an expensive bauble, of which I am rather proud on account of its accuracy in timekeeping and, as it is fitted with repeating, center-seconds, stop and fly-back movements, it is undesirable to get it into the hands of the ordinary watchmaker. It is not every watch repairer who can put one of this type of watch together again after having taken it apart, without having a few pieces left over at the finish, and those who can generally like to be well paid for doing it. I happened to mention my trouble to one of the foremen at the works and, as I was a stranger in a strange land, asked him if there was any reliable place in the neighborhood where the demagnetizing could be accomplished. He did not know of any place, but said that if I cared to let him "have a go at it" and take the risk he would try and effect a cure. As it was worse than useless in the condition it was in I let him "have a go;" this was how it was done.

Taking a piece of soft string he passed it through the ring of the watch and doubling it, took the two ends of the string between the finger and thumb of one hand. He then twisted the watch around with the other hand until the string had as many twists in it as was convenient. Then holding the string vertically so that the watch was suspended at about a yard from the magnet fields of a motor, it was allowed to revolve, by virtue of the twisted string, and at the same time was oscillated like a pendulum toward and away from the motor, approaching at the nearest point to within about three inches, but revolving all the time. This operation was repeated twice or three times on each pole of the motor and the watch handed back to me as cured. Cured it certainly was, as it has gone ever since without any kind of adjustment, and it has kept time as accurately as ever it did, but whether it is demagnetized or not is quite another matter.

Fiume, Hungary. MIMECHE.

Face Plate Attachment for Accurate Tool Work

A description of this tool will, I think, be of interest to those who have accurate hole spacing to accomplish, as it is simple and cheap to make, and considering its size, takes care of a surprising range and variety of work.

It makes use of size blocks or plugs for locating the various holes and is used almost entirely on the lathe on such work as subpress and compound press tools and jigs; and on this work has given very satisfactory service. Its disadvantages are that it requires the work to have two square edges to locate from and is somewhat slow; it can be used quite conveniently on the universal miller with vertical attachment when the sizes of the holes required permit.

A, Fig. 1, is the main plate of cast iron finished 5/8 thick, and attached by screws and dowels are the strips *B B*; these are dead square both with each other and the plate. Through the plate are about 40 holes arranged in staggered formation, and as near as can be conveniently, alternately plain and tapped, the plain holes to accommodate the pillar clamps or stops *D*, shown in detail in Fig. 2, and the 3/8 tapped holes for the ordinary flat clamp *C*, shown also in detail in Fig. 3. The mouths of the plain holes are rounded to allow the pillars *D* to push in readily.

This combination of a large number of closely pitched plain and tapped holes allows the work to be shifted about on the plate and located by size blocks for the various hole centers, and yet not get beyond the clamping range of the device. The pillar screws are slender and are used mainly for the purpose of keeping the work in contact with the size blocks; the clamping being done by the strap *C*, and one or more of these being used as the size of the work permits.

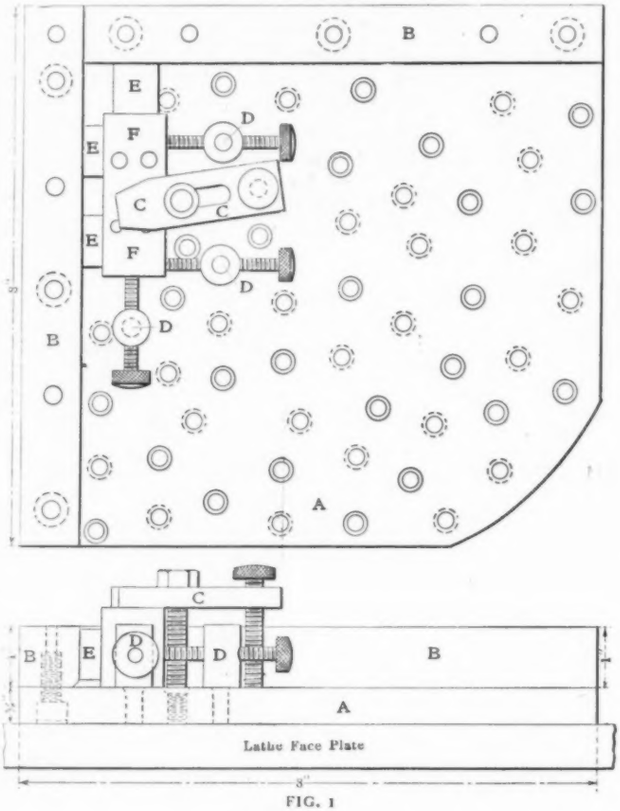


FIG. 1

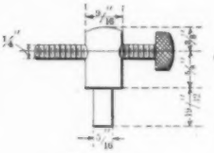


FIG. 2

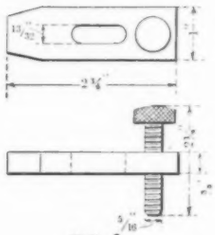


FIG. 3

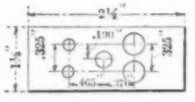


FIG. 4
Sub Press Punch Blank to be Bored.

American Machinist, N.Y.

FACE PLATE ATTACHMENT FOR TOOL WORK

The operation of the tool needs little explanation. As before stated, two edges and a face are squared up on the work to be laid out, and the center of the hole furthermost from these edges is laid out with the hight gage. The piece is now put on the plate with the finished edges in direct contact with the locating strips, the plate is then shifted about on the lathe face plate until this center is shown to run true by means of the center indicator and then firmly clamped.

All subsequent settings are made with size blocks of correct thickness interposed between the faces and locating strips, and the clamps are adjusted to any holes that may be convenient. In Fig. 1, at *F*, will be seen the subpress block (detailed in Fig. 4) in position for boring the last hole located by 0.835 and 0.325 size blocks *E-E*.

These size blocks can be made easily by cutting off ¼-inch round cold-rolled steel a few thousandths over thickness and grinding to size after case-hardening.

Manchester, England. GEORGE E. GAY.

Quick Change Gear Mechanism

This feed-change gear box provides six changes as indicated in Fig. 1, which is a longitudinal section through the driving-shaft center, showing the interior mechanism. The principal feature in this device is the adoption of friction rings in place of keys to avoid jumping and quick starting of gears while the change is taking place.

In Fig. 2 will be noticed in cross-section three operating rods *J*, one for each pair of frictions, and Fig. 1 shows how these operating rods are slotted crosswise to receive the connecting pin *K* in nurled knob *A*. These rods are held from turning in the gear case by collar *I*, which has pins inserted to follow the grooves in the rods, thus keeping the rods from revolving with the driving shaft.

The nurled knob *A* is operated endwise by hand lever *B*, carried on a stud which has an eccentric end fitting the circumferential groove in *A*. The end view of the knob *A* shows the dial markings. For the feed desired, *A* is turned until the required number comes to the top.

A spring pin *L* gives the handle a positive position for every rod, thus enabling the operator to set for the feed desired at a glance.

The friction-opening mechanism is shown clearly in Figs. 3 and 4. The pin *C* which is adapted to turn in its seat and so act upon either friction-opening pin *G* or *H*, has an eccentric extension which fits the slot in the sliding bushing *D*, Fig. 1, operated by rods *J*. This slot is elongated, as seen in Figs. 2 and 4, to allow for the travel of pin *C*. To operate the frictions turn the nurled handle *A* to the desired feed, and as indicated on the hand lever turn to "in" or "out." Thus, if the hand lever *B* is set at "out," the friction *E*, Fig. 4, is in operation through contact of the angular face of pin *C* with spreading pin *H*.

The angular surface on pin *C* has relief at the sides from the friction-opening pins *G* and *H*, therefore leaving pin *G* idle when *H* is engaged, or *vice versa*. This same operation may be repeated in connection with any of the rods *J*.

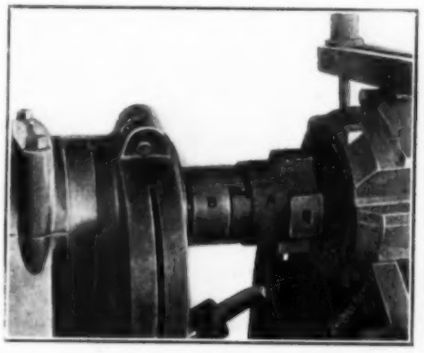
It will be noticed also that knob *A* cannot turn from one rod *J* to engage another while hand lever *B* is set at "in" or "out," the reason being that pin *K* in *A* is then not opposite the slots in either of the other rods.

The thrust of the operating rod *J* on bushing *D* which oscillates pin *C* is taken by ball bearings at either stroke of hand lever *B*. The double ball-race collar *M* is connected, as shown, with the bent inner end of operating rod *J*. Each feed is released before another is thrown in, all the gears not in use running on the bushings.

Springfield, Vt. R. R. F.

A Boring Head

The halftone shows the handiest boring head I have yet seen. It is used in the Ball Engine Works, Erie, Penn., on a horizontal boring machine. The head *A* is bored a snug sliding fit for the bar, which is turned a little larger at the place where the head seats than it is for the rest of its length. The bar is also provided with a cast-iron driver *B*, which is secured to it by pinning or otherwise.



A BORING HEAD

The head is also made of cast iron and locks on the driver by a species of bayonet lock. The pressure of the cut keeps the head solid in its seat in the driver. When the photograph was taken the head was slackened back so as to show the lock.

New York. E. A. DIXIE.

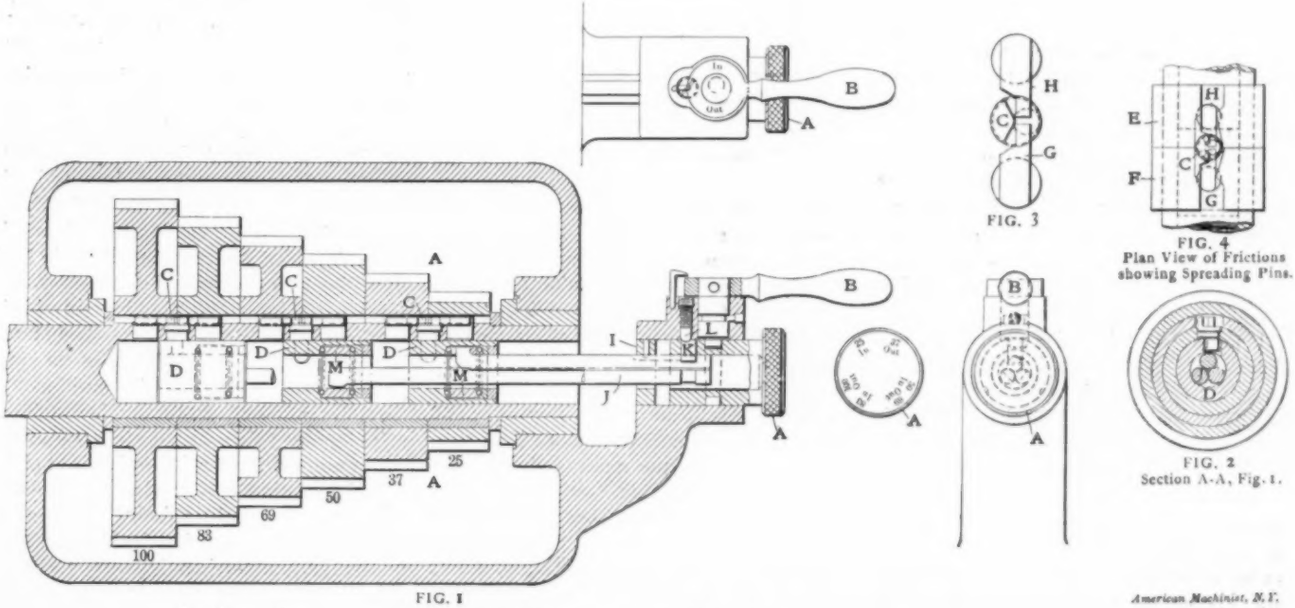


FIG. 1

CONSTRUCTION OF GEAR BOX

FIG. 3

FIG. 4
Plan View of Frictions showing Spreading Pins.

FIG. 2
Section A-A, Fig. 1.

American Machinist, N.Y.

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Re-tiring Locomotive Wheels

In taking off tires I have tried to heat them over a coke fire, and found that it took six or eight strikers to move the tire, even when wet clay was put all over the wheel center, to keep it cooler, but after a few attempts, I hit on the following plan, which is much better, as nothing is damaged, and the cost is a mere detail.

The wheel is put down on the molding-shop floor, and a bank of loam piled up around it, about 18 inches larger than the diameter of the tire, then after the different molds were filled, the metal which was left in the ladle was run around the tire, which loosened it in a few minutes, and allowed the wheel center to be lifted out and the tire removed before the metal was quick set.

I have found that if a flanging furnace is available, it is much quicker and cheaper than a gas ring. We have a tank in the yard about 8 feet square and 5 feet deep, nearly level with the ground. Two bars are laid across the top and the tire heated in the furnace, which takes from 3 to 5 minutes, according to the size of the tire. The tire is conveyed from the furnace to the tank on an iron hand truck, placed on the bars, and the wheel center, which is already slung in a pair of chain blocks above the tank, dropped into the tire, which is cooled with a pail or two of water until it grips. As soon as the tire grips the wheel, they are both hauled up by the blocks, the bars removed from the top of the tank, and the wheel and tire lowered into the water, which cools it much quicker than pails of water being thrown on.

I think our method compares very favorably with "Nemo's," as there is no cost for gas, and another thing, I have had repeatedly as many as three wheels tired per hour, by two men and one lad, which makes 27 per day of nine hours, against his six in the same time.

I might say that the furnace is not lighted specially for putting tires on; it is used all day for flanging boiler plates, and the tires are put into the furnace, in between the boiler plates being operated on in the flanging press.

Another good tip is to use the flanging furnace for case-hardening, as it has to be kept lighted all night in any case, so as to be ready for the men in the morning, therefore, the case-hardening costs nothing for fuel, which is a very considerable item on the cost sheet at the year end.

Leeds. J. D. S.

Drafting Table Light

The line cuts show a method of lighting the drawing board, which, while probably no better than the one shown by C. J. Mitchell on page 420, is easier made, and has proved itself to be all that can be desired for light. My table top is placed against the wall with a window directly in front. Fig. 1 shows a plan view, while Fig. 2 is an elevation. *A* is a rod made from ½-inch round steel, about 40 inches long with 5 inches at one end bent at an angle of 90 degrees, as shown. *B* is a bracket made from 1¼x¼-inch flat steel, which is screwed to the window frame about two feet above the table top. Rod *A* is inserted in the bracket and the light, which hangs directly over the center of the table and is suspended from the ceiling, is hung on the rod by means of a piece of wire bent to an S-hook. The wire can be slipped through the light cord at any point as the cord is double and twisted. This provides for up-and-down adjustments. The rod can be swung to any position desired and the light can be pushed to any point on the rod which allows placing the light at any point over the table. When not in use, the light is pushed along the rod to the wall and the rod swung over against the wall, which places it out of the way.

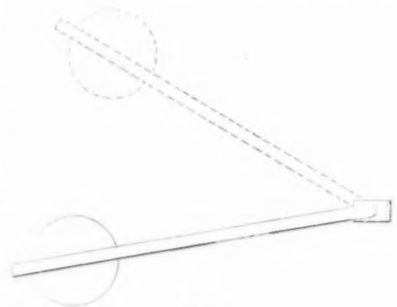


FIG. 1

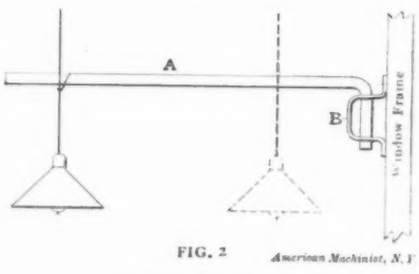


FIG. 2 *American Machinist, N. Y.*

DRAFTING-TABLE LIGHT

Moline, Illinois. S. S. S.

Stamping Titles on Tracings

On page 363 mention is made of the difficulty in getting perfectly opaque letters when rubber stamps are used with the usual black pads. This trouble is often overcome by dusting a little bronze powder on the newly stamped title. This, however, involves loss in time waiting for the ink to dry before dusting off the surplus powder, and involves careful handling in the meantime.

A very rapid and convenient method in use in one shop which uses a great many detail drawings is to have the printer print the standard title including the firm name, place for date, check, approval, file number, etc., on small oblong pieces of tracing cloth cut from scraps, several hundred being printed at a time. A space is left for the title which is filled in with ordinary free-hand lettering. A touch of mucilage applied to each corner serves to attach the title to the tracing. Of course, in the case of prints that are not over printed the oblong space for the title is of a slightly lighter shade than the rest of the print, since a double thickness of cloth is printed through, but this difference is not objectionable, especially in view of the sharpness of the printed titles. Some of the individual draftsmen prefer to attach the printed title to the back of the tracing, filling in the title proper with date, file number, subject, etc., on the face. This insures the tracing carrying its own identity should the title ever become detached.

A modification of this plan is worth considering, although it was tried before adopting the method above described. It consisted in using one carefully hand-lettered title only for making all prints. It was printed on a piece of tracing cloth of such size as to include the border of the regular tracings, and the individual file number, subject, etc., was merely lettered in the right place free-hand. For the purpose of readily locating the position for these figures each draftsman had a blueprint of the title which he slipped under the corner of the tracing before filling in. The title tracing was attached permanently to the corner of the printing-frame glass and it only remained for the blueprint boy to always spot tracings by merely placing them in the corner, the edges against the sides of the blueprint frame, so as to bring

the details of the title to exactly the right place. This method, of course, cannot readily be used where electric blueprinting machines are in use, but it is well worth while in an office using flat frames for solar printing, and where the number of tracings made is small, or where the objections of someone who watches the small outside bills closer than the pay-rolls would prohibit having a number of separate titles printed.

Kellarville, Ills. E. W. FISKE.

The use of rubber stamps described on page 363 brought to my mind a method I used several years ago for numbering drawings.

We used large type, printed them with rubber stamps and regular pad ink. Before it was dry we touched the print with a drawing pen filled with regular black drawing ink, which flowed all over the wet characters. This was done because the pad ink would not print out well on the blueprint.

When the titles and border lines are put on the tracing cloth, I think the best scheme is to print them on the dull side, which not only keeps the tracing straight, but as we use the glossy side for drawing, I find it useful as it is sometimes necessary to change the title, which can easily be done without disturbing the printing. Of course, this means that the printer has to use left-hand type.

Dayton, Ohio. CINCINNATUS.

Coaster Trucks, a Dangerous Practice

Under the heading, "Coaster Trucks in the Shop," on page 448, I notice your correspondent seems to advocate the practice of the errand boys riding on the low truck, while they push it along with their leg. He writes, "rapid time" is made. Here is just the danger; the boy often makes such rapid time that when his pathway intersects with any of the passageways about the factory there is great danger of a collision with persons walking about the factory. I have seen many hair-breadth escapes from a serious injury to such persons. Often the foot passenger is walking rapidly, his mind intent on other matters than looking out for errand boys with trucks and at the intersection with another passageway he suddenly comes upon the boy coming along at a rapid pace with his truck. The boy does not notice or perhaps cannot see the foot passenger coming from another direction, and he is going so rapidly that he cannot stop in time to avoid a collision. The only thing that saves the foot passenger from injury is his ability to side step quickly.

Many factories will not allow this practice and it seems to me to be too dangerous to be publicly advocated.

Beverly, Mass. W. S. B.

Accuracy—A Comparative Term

On page 140, "Accuracy—A Comparative Term," by Entropy, hits off a question that has often caused me, and no doubt plenty of others, some quiet amusement. Practical accuracy, I take it, is the knowledge of working to such limits as are justified by the function that the article being manufactured has to perform. I have often noticed the differences among men in using sensitive accurate tools, especially the vernier and micrometer. How many men use a micrometer alike? Some are very heavy handed and use it like a spanner, others use the ratchet stop to feel with; for years I have never used any other micrometers than my own; I make a point of never lending them to any one, as I set them by standards to "my feel" and recommend others to do the same.

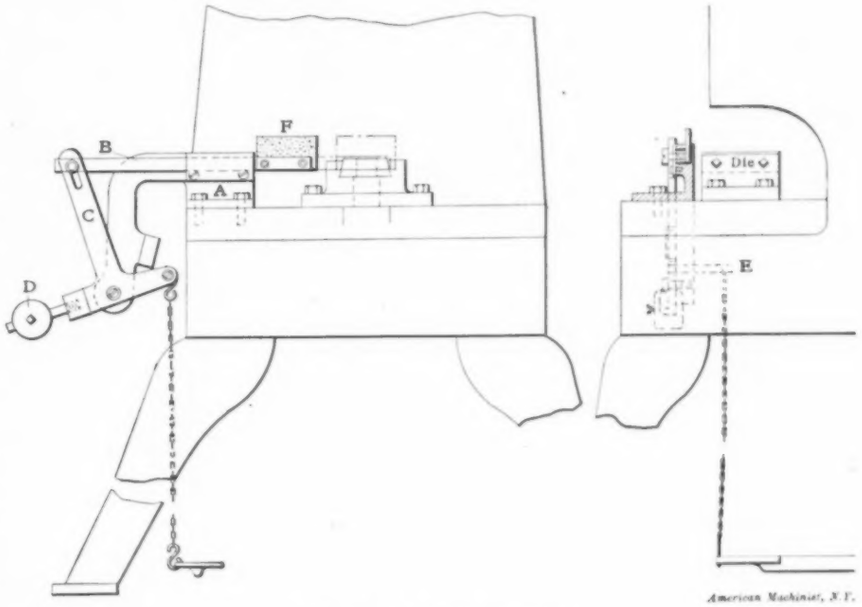
As Entropy says: In the small shop the workman has a greater knowledge of the part his work has in the building up or making of the finished article, and has, therefore, a clear insight regarding sizes which are of importance and those which are not. In the large firms, that are run on the uptodate method, the workman has generally no knowledge of the finished tool or machine, only working to blueprint, tracing or sketch of the part that concerns him and on which the sizes are very often written alike. No distinction is shown as to parts where 0.0005-inch limit is absolutely essential, and to others that fit the air. As a consequence, the small shop has less scrap and less wasted time than the larger one; if it were not so no small concern could exist, for although the large organizations are run in uptodate ways, it is sad to think of the great wastage through this same organization in some parts of their ponderous systems.

London, England. N. H. HOMER.

A Safe Finger Guard for Power Presses

I was interested in A. Henry Matson's sketch and explanation of a "Safety Trip for a Punch Press," on page 190, but what an affliction to impose upon an operator. I claim for the guard shown herewith, safety combined with speed and adaptability.

This guard is so constructed as to bring a shield right across the front of the press tool before the punch descends, therefore, as it operates in front of the punch, should the operator's fingers be in the way it will push them out of danger before the punch is low enough to catch his hand.



A GUARD FOR A PUNCH PRESS

This guard is made up with a cast-iron bracket cored out to receive a piece of flat iron for a slide, and fixed to the table of the press by two ⅜-inch set screws, slots being cored in the base of the bracket for adjusting the position. There is also a cranked cast-iron lever which operates the slide. This is connected to the bracket and slide by shoulder screws, the lever being slotted to allow for the travel of the slide as shown. A piece of ⅜-inch round steel is screwed into the bottom end of the lever with a small hole in the end into which is inserted an S-hook to carry a small chain leading down to the pedal of the press. I find it necessary to have right and left finger guards, as some jobs require a guard on the left-hand side and others on the right-hand side, so by drilling a hole on each side of pedal it is easily changed from right to left. *A* is a cast-iron

bracket; *B* is a mild-steel slide; *C* is the crank arm; *D* is a cast-iron balance weight to bring the slide back directly the operator releases the pedal for the next movement. Should the operator keep his foot on the pedal and the press continue running, he cannot easily get his finger into danger because the shield will remain in front of the die, thereby compelling him to release the pedal for every operation. It is common and dangerous practice for expert operators when on piece work to try and catch every stroke of the press. *E* is a piece of ⅜-inch round iron screwed into the crank arm in which is inserted the S-hook for connecting the chain. I find a chain the most convenient connection as you can take up or let out a link, according to the travel required by the slide. *F* is the shield made from a piece of ordinary 3-inch belt leather and fixed to slide by two 3/16-inch screws.

JOHN L. HAMILTON.
Edinburgh, Scotland.

Unproductive Time

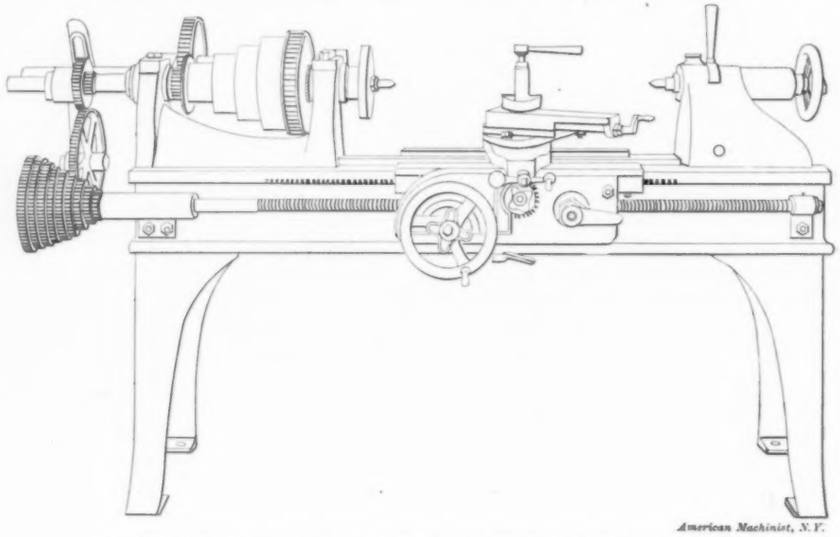
I was interested in the editorial on "Unproductive Time," page 152. A reminder is always helpful, and the first questions that present themselves when figuring out the cost or time of a job are: How and where is the job to be done, what tackle is there suitable and how long will it take to rig up, etc.? Such questions can be answered mentally or after investigation.

The question of cutting speed usually requires very little consideration for there are ample data for speeds and feeds for the various metals and operations. Besides a man who has to do this figuring out soon collects his own data, based, not on what the book says, but upon what can be actually accomplished in his own shop. The careful investigation of the unproductive parts of the operations takes up the most time and to my mind is the only way of arriving at even an approximate result, for the consideration of cutting speeds unless accompanied by the result of a careful consideration of the unproductive operations, will not be very reliable. On some of the more complicated jobs it is necessary to make an allowance for eventualities, for our conclusions are only theoretical and based on the assumption that everything will go right, whereas in practice usually something unforeseen crops up, no matter how careful our investigations have been. This, too, is in addition to delays caused by defective material or breakdowns, etc. Sometimes when machining, say, a casting, the machining time of which has been carefully considered, some part may be found to be chilled or to have a hard place in it, or, again, it may be distorted, either of which may cause extra time to be spent in machining or setting and in the case of a piece-work price having been fixed an extra allowance will have to be made in addition to the extra already allowed for eventualities included in the original price. When noting the discrepancy between the time per piece and the number per day this and other causes of delay must be taken into consideration.

Sheffield, Eng. MARK DALE.

A 16-inch Lathe of 1876

Dixie's descriptions of old tools set me to looking through my older catalogs and photographs with the result of unearthing a catalog published in 1876 by Ferris & Miles, of Philadelphia. Your older readers will recognize this firm as ultimately consolidated with William B. Bement & Son into Bement, Miles & Company, now one of the parts of the Niles-Bement-Pond Company.



16-INCH SWING LATHE WITH PATENTED SCREW CUTTING ATTACHMENT

In this catalog was a cut of the 16-inch lathe shown herewith, which compares favorably with present-day practice and is more than can be said of some of those that Dixie has brought to light. The proportions, as can be judged from the swing given and the width of belt stated to be 2½ inches, are essentially modern. The quick-change gear device is rather awkward in appearance, but it has merit in its simplicity that can well be studied. The device for cutting left-hand threads is not shown, but I am told that provision was made by substituting two smaller idler gears for the one shown. The feed was splined screw with reverse in the apron controlled by the handle shown below the hand wheel. Both cross and longitudinal feeds were thrown in by friction clutches.

The cross slide shown is peculiar in that the screw travels with the slide the same as that of the compound rest. This was one of the features of all their lathes at that time. If this lathe was to be brought out today with a neat looking cover over the gears and a well made half-tone cut used to advertise it, I doubt very much if anyone would accuse the builders of being old fashioned, which only goes to show that history repeats itself or else that some things are born prematurely.

Worcester, Mass. E. H. FISH.

An Anti-Chattering Device

In answer to Cadillac, who comments on page 451 in regard to my anti-chattering device, I wish to say that working along the line of his hypothesis may be all right when one has the time to determine the source of the trouble; but in my experience I have found that no hard-and-fast rule applies.

At the time I devised the arrangement I described at page 968, Vol. 31, Part 2, one of the men had been trying to make a good job on a shaft 1½ inches diameter, about 6 feet long, in a lathe at least 25 years old, which had received about every imaginable kind of abuse. It was a hurry-up job and we had tried about everything that our imagination or ingenuity could suggest; varying feeds and speeds, and the old kink of making the point of the cutting tool the width of the feed but to no purpose, and while using two back rests. We not only got heavy chatter marks but managed to get more or less taper on the work until the device mentioned was applied, when our trouble ceased. I have not applied any theory, but the fact sufficed.

I greatly doubt if any appreciable amount was added to the power consumption, though I am open to conviction.

I could mention many different ways in which I have overcome the trouble in as many different cases, but no particular one will fit every case as well as the scheme I described; or rather, it is the best I have found.

Lowell, Mass. WM. B. HILLIARD.

Crowning Pulleys on Engine Lathes

Regarding the article on page 393, by E. W. Harris, on pulley crowning on engine lathes, and also the editorial comment on how the pulleys are turned and crowned in quantities in the United States; the two halftones herewith show the methods used by the Lodge & Shipley Machine Tool Company in connection with the equipment which is regularly supplied with their lathes.

Fig. 1 shows a Lodge & Shipley lathe arranged for doing this work. Fitted to the face plate of the lathe is a compensating driver *a*, on which are the driving jaws *b*, which drive the pulleys by the arms. At the center of this driver, and having a bearing in the spindle is the arbor *c*, on which the pulleys are placed (after having been bored and the hubs faced), and tightened in place by nurled nut *d*. The end of the arbor *c* fits in a female bearing *e* attached to the tail spindle which is brought into place after clamping the pulleys on the arbor. At the back of the lathe is the forming attachment *f* which is the proper arc for the crown, being made either circular or with straight lines at the proper angle. Two pulleys are crowned at one time by having the tool block *g* on the compound rest arranged for two tools, which will not only turn and crown the pulleys, but face and round the edges also. There are two sets of tools *G* and *H*. *G* is for roughing at a coarse feed once across the face of the pulley. It is quickly removed and replaced by the tool block *H* for finishing.

The same arrangement is carried out in turning and crowning cone pulleys as is shown by the fixture *j*, Fig. 2, where three tools are in place for crowning a three-step cone pulley.

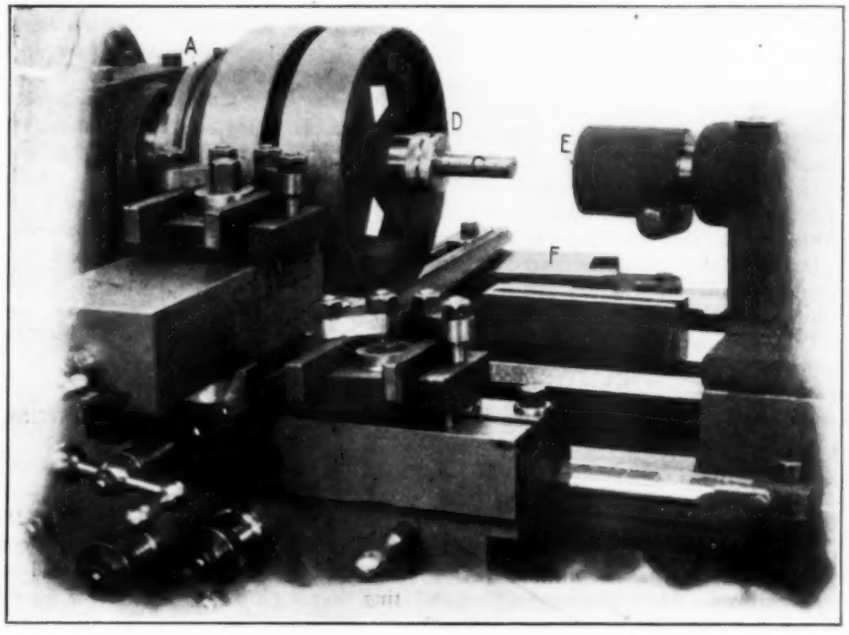


FIG. 1. CROWNING TWO PULLEYS AT ONCE

On pulleys 12 inches in diameter by 3½-inch face, we can turn out 120 in 10 hours when done in this manner, and we do not know of any special pulley-turning tool which will do as much work.

J. W. CARREL.

The Lodge & Shipley Company,
Cincinnati, Ohio.

Construction of Boring Bars and Micrometers

In a recent issue of the AMERICAN MACHINIST I notice a number of tools of Mr. Bocorcelski, of the Baush Machine Tool Company, and as the main features of these tools are "the use of a stationary screw with an internal spindle, which is moved by a cross-bar or pin acted on by a groove inside the nut," I would like to inform you that these features were applied to and used in the "Nelson" hollow boring bars, on which I applied for a patent nearly four years ago. These bars were described and advertised at the time and were sold quite extensively in Chicago. As I am thinking seriously of again commencing to manufacture these tools, I make these statements to show my priority of invention.

GEO. A. NELSON.

Formerly of the "The Grant-Nelson Tool Company," Chicago, Ill.

Machine vs. Hand Work on Steel Stamps

On page 417 Mr. Coppack questions the superiority of hand work in making steel stamps. It is a recognized fact that in all cases where the conditions can be met that machine work is always superior as well as more economical than hand work, but applied to steel stamps, I have yet to see a machine that would meet the conditions and cut good steel stamps from tool steel.

Here are some of the reasons that, in my opinion, make steel-letter cutting by machine an impossibility. First, any machine using a revolving cutter must leave a radius in every corner of such letters as *M* and *W* and figure 4, which, of course, would not do. Second, in cutting 1/16 letters, which is a most common size, it is obvious that the diameter of the cutter could not be over 1/32 inch. Would such a cutter stand up on tool steel?

Regarding the cost of making steel stamps, a man on this class of work will easily turn out in one day 12 sets of figures (size 1/16 inch), or four sets of letters complete—including hardening and

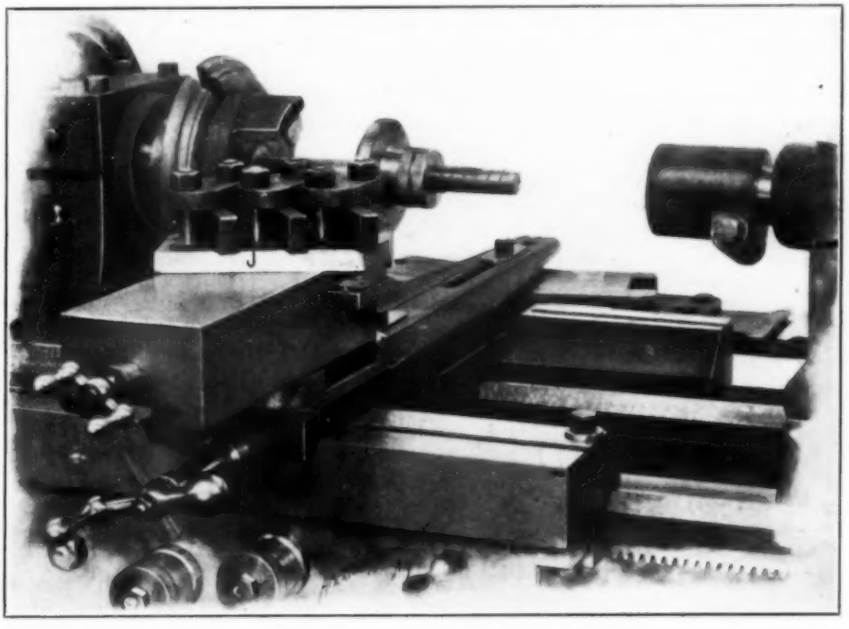


FIG. 2. FIXTURE FOR CROWNING CONE PULLEYS

tempering. I have often made a set of figures in one hour and it has been done in less than one-half hour. Hand-cut steel figures can be bought as low as 45 cents per set, but the best cost in the market about $1.25, and this is the grade of work to which my article on steel stamps referred.

I have been greatly interested in attempts at producing a machine to do this work, and if a machine can be built to do the work as good and as cheaply as by hand it will find a ready market. While I doubt that this can be done, I'm from Missouri, and if Mr. Coppack can favor us with a description and illustration of the machine in his town it will be greatly appreciated not only by the writer, but by the mechanical public in general.

Boston, Mass. E. P. Noyes.

A Piston Ring Jig

On page 73 I notice a jig for grinding and turning piston rings for internal-combustion engines, described by Mr. Lovejoy. I regret to throw cold water on this jig, but having been up against the same thing myself, I found that a reasonably tight ring could not be produced in the manner described. I will attempt to illustrate the fixture made to produce a satisfactory job.

After the rings have been rough turned and bored they are parted off and faced on the expanding mandrel, Fig. 1, both faces being operated on at once by the special design of revolving tool head, Fig. 2, containing 3 sets of cutters, and used in the ordinary engine lathe. It is so constructed that by turning the tool head through an angle of 120 degrees a fresh pair of cutters is presented to the work, taking three cuts in all to finish. As no shifting of the slide rest to put on the cuts is required, perfect interchangeability is easily maintained.

Now, if a piece is cut out of such a ring and the ends brought together its natural shape will be more or less elliptical. Fig. 3 is traced off a 5-inch ring after cutting out ¾ inch, and shows a variation of ⅛ inch from circular. By inserting this in a stiff collar as described by Mr. Lovejoy the trouble begins. An unequal strain is set up in the rings which, when turned, will prevent them setting up an even pressure on the cylinder walls.

To produce a perfectly tight ring it is essential that an equal outward pressure be offered to the cylinder walls. The method of obtaining this is to insert all the rings, after splitting, with the cuts parallel in a flexible ring, made by boring and turning a weldless steel tube to about 1/64 inch thickness. The lugs are made separately, screwed together and brazed on, after which the tube is split, thus maintaining its original size.

This tube, containing twenty-four ¼-inch rings is now slipped into the register-plate, Fig. 4, the yoke put on and nuts tightened. They are then bored to finished size, after which they are removed, slipped on the turning mandrel, Fig. 5, and the end plate and clamping nut pulled up tight. The flexible ring can now be removed by loosening its small clamping screws and the rings turned to within 0.010 of finished size.

Before releasing, a second flexible ring is pushed over and the end clamping nut released and retightened. This is done to remove any strains that may be left in the rings after removing so much stock at one operation. The clamping nut is again retightened, the flexible ring removed and the rings ground to finished size.

The second flexible ring need not be split and no difficulty will be experienced in removing this if four small lugs are brazed on outside to catch hold of. The rings very nearly approach circularity when restrained. Fig. 6 is traced off a finished 3¾ ring open. It will be noticed the variation from the circle traced outside. By this system a perfectly tight ring can be produced which will wear no unevenness in the cylinder bore.

Birmingham, England. T. Thomas.

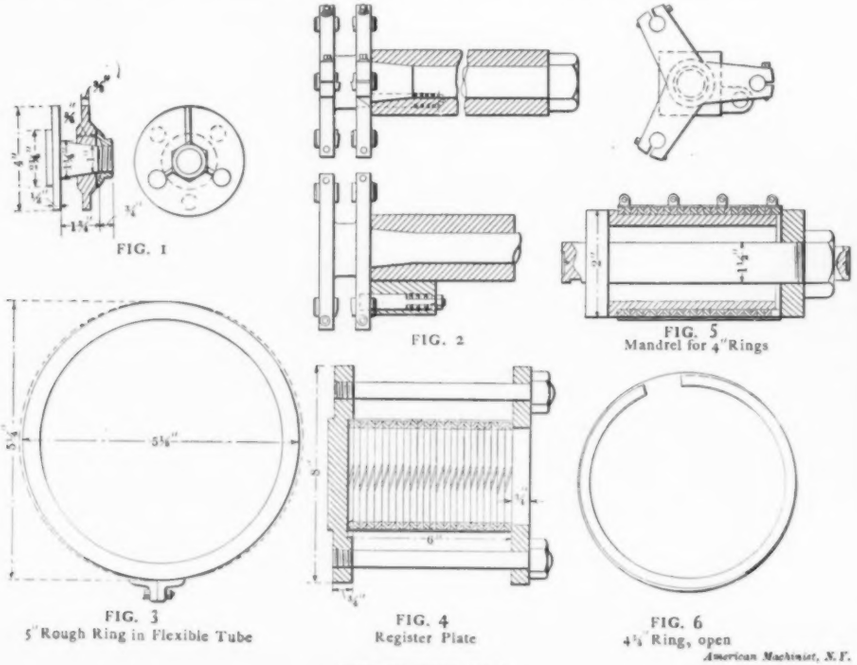


FIG. 1

FIG. 2

FIG. 5
Mandrel for 4"Rings

FIG. 3
5" Rough Ring in Flexible Tube

FIG. 4
Register Plate

FIG. 6
4¼" Ring, open

American Machinist, N.Y.

PISTON RING JIGS

Quick Japanning

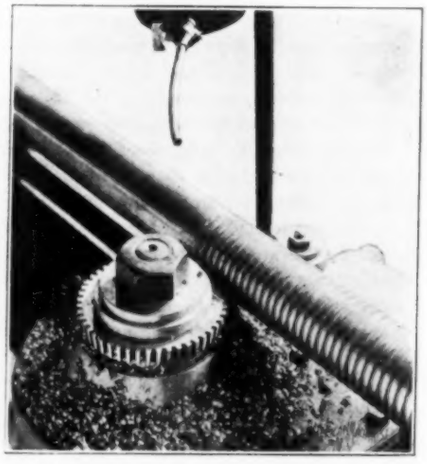
In answer to W. B., Preston, Eng., I would say that he might use drop black ground in Japan if his pieces are to be black or any other color. If one side only is to be japanned he can use a brush, if both sides, make a vat and use a frame with wire braces set at an angle of 60 degrees, as it requires only a short time to set the color, he will find this much quicker than baking.

If not glossy enough with one dip he can use an air-drying varnish as a second. I have used this on jobs that had to be A-1 and in a hurry, and have always had good results.

Erie, Penn. Bert Smith.

Thread Cutting with a Forming Cutter

We are informed by the Newton Machine Tool Works, Philadelphia, Penn., that they have been using the thread-cutting device shown herewith for a number of years, antedating the French machine recently illustrated, and that their French patent lapsed from their inability to manufacture in France within the specified time. This is an attachment to the carriage of a lathe and is used in cutting feed and other long screws.



METHOD OF THREAD CUTTING

AMERICAN MACHINIST

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April 8	19,250
April 15	19,250
April 22	19,250
April 29	19,250

This paper reaches 34,750 *separate readers each month and* 19,250 *each week.*

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

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The Largest Small Advertisement in the World

With this issue of the AMERICAN MACHINIST begins a five-year order for sixteen pages of advertising weekly for one concern—the Niles-Bement-Pond Company.

So far as we can find, this is the most space ever ordered for so long a time in any periodical, much less a technical one.

But this is a moderate, even a small, advertisement for so big a concern. There are plenty of larger advertisers in the paper.

Advertising is for the purpose of exploiting the products the advertiser has for sale, and should be proportioned in size and cost to his output.

This great concern is the largest maker of machine tools on earth, and the product of its shops is so large, and the variety so great, that 20 pages a week would not advertise them as well as many machine-tool makers of a single line are now advertised in this paper.

We believe that this concern is the best example of the large corporation in business without a tendency to become a trust, to monopolize, to crowd the mourners.

They expect, and do get, advantages of volume of business and are entitled to it, but we have never heard of their attempting to use their size and strength to play the hog.

They go after the business as any live firm does—aggressively; they are in competition; they advertise and hustle and hunt trade, like the rest of us.

We are somewhat gratified to have the distinction of publishing the largest advertisement for the most times, but bless you, there are hundreds of general advertisers who spend twice this money in half this time in their advertisements.

For the past five years the Niles-Bement-Pond Company has had six pages per week in this paper—now it takes sixteen—which is as good a testimonial as we want.

The Optimism of the National MetalT rades Association

It is extremely gratifying to all who realize that true industrial peace must come from satisfaction on both sides, and that the attitude of victor and vanquished is never conducive to lasting harmony, to note the general tone of optimism and fairness that pervaded the annual meeting of the National Metal Trades Association. Organized for a purely defensive purpose it has outgrown or added to its scope until its mission seems destined to be much larger, broader and better than its founders dreamed: to become a force for improvement in many industrial conditions.

The makers of the program were broad-minded enough to include two papers on profit-sharing, to have the president of a labor organization address them and to listen to the suggestions of an expert on liability law even though he advocated changes which will add the accidents of a business to its liabilities or fixed charges. All these men had a message, more or less palatable, according to individual tastes, and their presence indicated a breadth of view that would have been hard to find a few years ago.

The committee appointed to study into the apprenticeship question are all earnest seekers after the best for all concerned and have had considerable experience along this particular line. Starting with the acknowledged necessity of paying a boy enough to live on without his parents' support and realizing the advantages to all concerned of teaching him all that his branch of the business requires, this movement promises improved conditions for boys in many shops and better trained workmen as a result. Those who know the men who have been selected realize that it means much for the boys who will be affected to have the question treated with the broadness and fairness that is sure to be the case, and more than that, with the personal sympathy, which means more than can well be expressed.

While profit-sharing, as set forth in the two papers presented, did not meet with general approval, there was a decided trend toward a broader treatment of the question of premiums or bonuses and of the piece-work plan. While it is pretty generally agreed that the majority of men prefer to have their share of the profits or earnings in the form of wages each week or month, it is probable that this feeling comes largely from a suspicion, founded on an ignorance of the business end of manufacturing, that the reports do not tell the whole story. We are all more or less suspicious and when this is backed by ignorance it is difficult to deal with.

For this reason, several of the manufacturers advocated less of the "none of your business" attitude and a greater recognition of the fact that all were, or should be working to make the business a success. Ignorance of the true condition often leads to disruption and none will deny that great ignorance exists. The average workman knows practically nothing of the vicissitudes and trials of the business end and has no means of knowing unless he is told. Even then he may be suspicious, just as we are apt to be suspicious of anything we do not understand. To one who only has to do with the making of an article, the selling end is a mystery and there is little wonder that all over the cost for the material and labor seems to be profit.

If a better idea of the true condition can be carefully and honestly shown, even at the cost of breaking down some of the

reserve between the shop and the office, there is sure to be less unreasonableness in the demands made. Such an understanding would prevent many of the conflicts with their losses and aftermath of bitter feelings and would lead to an understanding which would make possible all necessary changes in hours, in wages, or in shop conditions in such a gradual manner as to work the least disturbance to business.

With such a spirit of mutual helpfulness, with the expressed desire to inaugurate better conditions for the training of apprentices, and with an open mind on the question of legislation affecting the remuneration of employees who are unfortunate enough to be injured in service, the members of this association are in a position to command the attention and respect of all who are interested in the betterment of shop conditions and the general welfare of the manufacturing industries of the country.

Patent Retaliation Abandoned

We are informed that, as reported to the Senate, the patent retaliation rider of the Payne tariff bill is omitted. Of course it may be replaced when the conference between the Senate and House committees takes place, but the present indications are that the provision will not be a part of the tariff law as finally passed.

New Publications

HANDBOOK OF SMALL TOOLS AND TREATISE ON SCREW-THREAD SYSTEMS. By Erik Oberg. 517, 5x8 pp.; numerous illustrations and tables. John Wiley & Sons, publishers, New York City. Price, $3.

This book, by one of the associate editors of *Machinery*, is intended as a treatise on the design and construction of small tools such as taps, dies, milling cutters, reamers, etc., and the material contained in its 500 and more pages should be of value to toolmakers, draftsmen, foremen and others requiring specific information on the small-tool subject. The book is of a practical nature, and while formulas and deductions of formulas are freely included, those not interested in the use of formulas can refer directly to the tables where the results sought for will be obtained without calculation. The author has prepared this matter after an extended practical experience on small tool work, and a great deal of the material he states has already appeared under his name in the columns of *Machinery*. The chapters describe in detail the different screw-thread systems; methods of cutting and measuring threads; types of threading tools, taps, dies and hobs; milling cutters of all kinds; reamers, drills, counterbores, hollow mills, lathe arbors. Tables are included, giving complete dimensions of these different classes of tools, proportions of standard threads, tapers, etc., and comprehensive definitions of the tools themselves are presented, along with practical points relating to their construction and use. The chapter on thread cutting describes different methods of doing the work, shows how the lathe change gears are determined for various threads, and explains the use of the thread micrometer, the ball point micrometer, the wire system for measuring thread diameters, the necessary tables, of course, being included. Various forms of threading tools, with the methods and devices used in finishing and testing them, are taken up in the chapter following. The chapters on taps and dies alone occupy, approximately, 175 pages, which are well illustrated and replete with tables and diagrams. Another important section which may be mentioned here is that devoted to milling cutters and forming tools, in which are considered conditions relating to the design and application of such tools, with information on making, grinding and operating. The book has a complete table of contents and is well indexed.

DES INGENIEURS TASCHENBUCH, HERAUSGEGEBEN VOM AKADEMISCHEN VEREIN HUTTE. 20th Edition; two volumes, cloth, 981 and 999 4½x7⅛-inch pages, respectively, with over 1600 illustrations, Berlin, 1908. Price (two volumes), 12 marks in linen binding, or 14 marks in leather binding.

This well known German engineering handbook was reviewed on page 757, Volume 28, Part 1, at the time of the appearance of the nineteenth edition, thus an extended review is not called for now. The innovation in this twentieth edition is the expansion into three volumes of which the first two are before us, while the third is promised for the latter part of the year. As now divided, Volume I deals with machine building, Volume II with shipbuilding, and Volume III is to treat of construction work. The price of all three volumes is to be 17 marks in linen binding and 20 marks in leather binding. The third volume is to be sold only to purchasers of the other two.

The Rochester Factory Schools

We learn from a circular issued by Arthur D. Dean, chief of the division of trade schools of the New York State Educational Department that the city of Rochester is the first city of the State to avail itself of the recent law providing for the establishment and maintenance of trade schools.

One of the public-school buildings of the city has been assigned for the purpose and classes in advanced and elementary wood-working and advanced and elementary mechanical and electrical work have been organized with an enrollment of 100 boys. A course of study in book work has been laid out, having a close degree of relation to the shop work. While the entire program is more or less tentative, the school is upon a working basis. Those interested in the subject may obtain a copy of Mr. Dean's circular by addressing him as above, at Albany, N. Y.

Personals*

W. S. Rogers, president of the Bantam Anti-Friction Company, sailed on April 29 for Germany.

Philo Kennery, for a number of years chemist with the Cresent Steel Company, Pittsburg, Penn., has recently been appointed metallurgical engineer of the company.

C. E. Pettee, who was formerly with the Westinghouse Machine and Tool Company, is now works manager of the Herman Pneumatic Machine Company, Zelienople, Penn.

F. O. Hoagland, department foreman with the Pratt & Whitney Company for a number of years, has become chief mechanical engineer of the Remington Arms Company, Ilion, N. Y.

William A. Baehr, chief engineer of the Laclede Gas Light Company has opened an office in Chicago as a consulting engineer, and will also act as western agent for Bartlett, Hayward & Co., of Baltimore.

Edwin J. Haddock has resigned his position as chief engineer of the Jeffrey Manufacturing Company, Columbus, Ohio, to engage in business for himself in that city as mechanical, structural and mill engineer.

Our contributor Guido H. Marx, associate professor of machine design in Stanford University, has been promoted to the rank of professor, the appointment to take effect with the beginning of the academic year 1909-10.

Jos. Leon Gobeille has recently established himself with the Gobeille-Harris Pattern Company, Niagara Falls, N. Y. He was formerly superintendent of patterns with the Abram Company Stove Company, Philadelphia, Penn.

Reginald A. Wright, formerly chief engineer of the Jenckes Machine Company, Ltd., Sherbrooke, Canada, has recently associated himself with the Philadelphia & Reading Coal and Iron Company, Pottsville, Penn., to act in the capacity of chief draftsman.

*Items for this column are solicited.

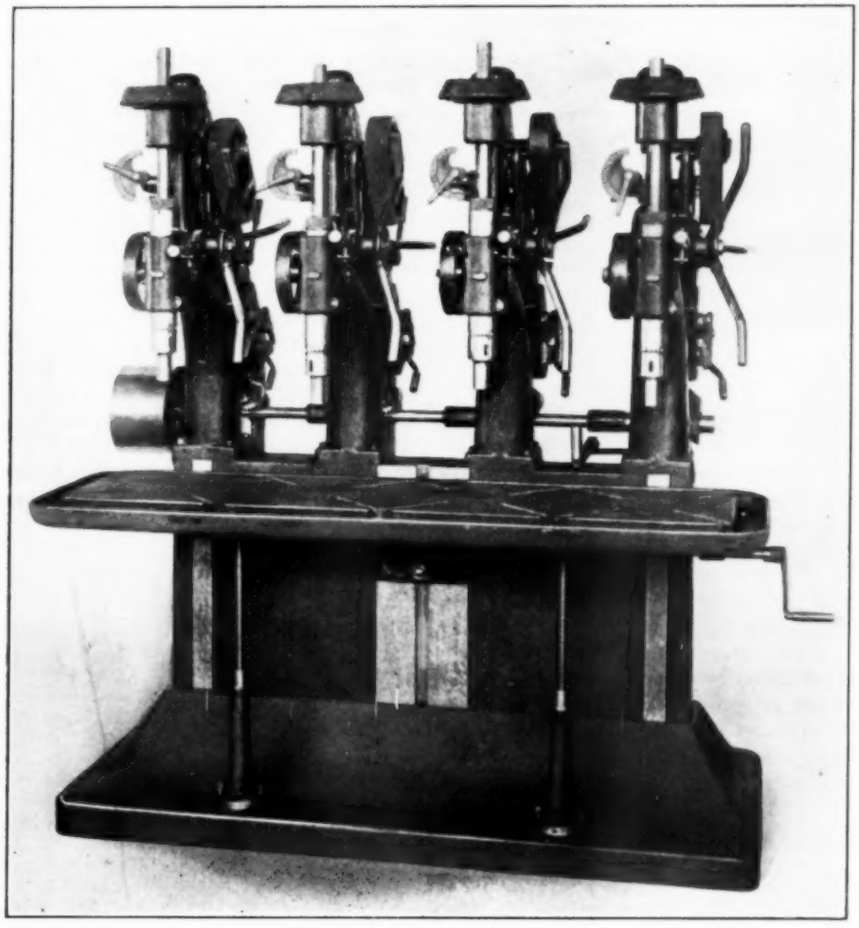
New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

Four-spindle Geared Drill

This embodies the same general principles shown in the single-spindle recently illustrated, and built by the Barnes Drill Company, Rockford, Ill. It is an all-geared drill, each spindle being independent and having eight speeds when back gears are used. The geared feeds range from 0.001 to 0.025 inch, and are controlled by the small levers on the toothed segments at the left. All feeds and speeds are under control of the operator without leaving his position in front of the machine.



FOUR-SPINDLE GEARED DRILL

The single table is supported by two screws which prevents the table springing under the thrust of the drill. A crank at one end raises and lowers the table. Separate tables can be supplied when the character of the work makes it advisable. Any or all of the spindles may be fitted with tapping attachments. This is a 20-inch drill, will handle twist drills up to 1 inch without back gears, and will drive a 2-inch tap in cast iron.

Newark Gear Cutter Grinder

This machine has been designed particularly for the grinding of gear cutters and nothing else, so that it is always set up and always ready to be used. On this account it is often possible to grind one or more cutters while the proper attachment is being put on a universal machine, and by reason of its simplicity the cost of the machine is low enough to allow its use even if only one gear cutter is in the shop.

The cutter to be ground is mounted on the stud *A* set into the table *C*, Fig. 2. This table is mounted on horizontal trunnion *C*, allowing it to be tilted up or down. This allows heavy pitch cutters to be ground in the corners between the teeth without changing the wheel or removing the cutter, as can be seen. This also affords instant adjustment for setting the cutter central with the wheel to suit cutters of different thickness. The machine will take cutters from 1¾ up to 8 inches, which includes all that are usually found. There is a pawl on the table which is adjusted to the back of the tooth to be ground, and after being ground the cutter can be rotated from tooth to tooth. This pawl has an adjustment by means of a screw so that a second cut may be taken if necessary, and each cut is radial after the cutter has once been set. No dials are necessary for indexing, as the pawl itself performs this function by operating on the back of the teeth.

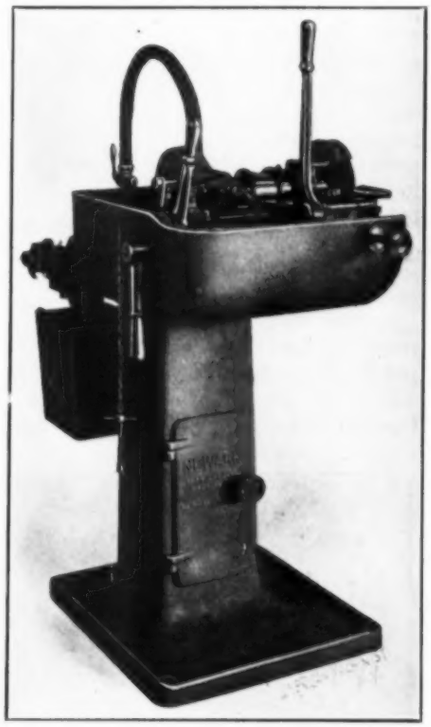


FIG. 1. GEAR CUTTER GRINDER

The grinding wheel is 8 inches in diameter, and mounted on a 1-inch spindle, which is hardened and ground and runs in phosphor-bronze bearing for wear. The spindle is extended outside the water basin, and a hand-grinding wheel mounted on the outer end, as shown. The grinding spindle is mounted in a carriage operated by the vertical lever which gives the grinding stroke across the face of the cutter, while an adjustable stop regulates the depth to be ground.

A centrifugal pump supplies water to keep the cutter cool and the grinding dust is separated by means of baffle plates.

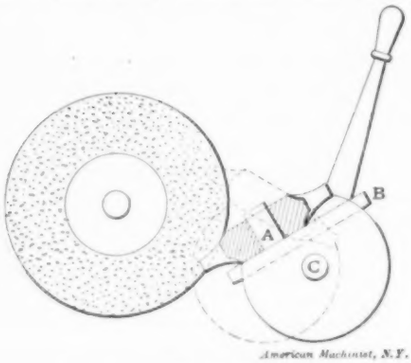


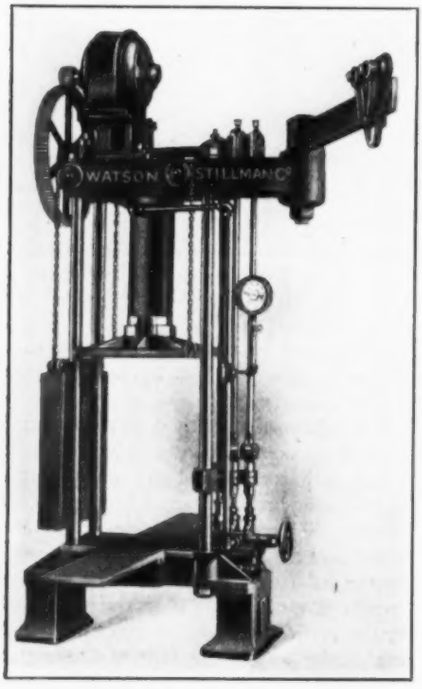
FIG. 2. ACTION OF THE GRINDER

The water drains from the basin down to the reservoir at the side of the pump. It will be noted that fixed handles are used wherever possible so as to avoid the use of wrenches, and in places where these are necessary they are fastened to the machine by a chain. The column is a true box form which can be used as a cabinet for cutters or grinding wheels. In addition to two grinding wheels and the diamond truing device, the machine is supplied with bushings to take cutters having from ⅞- to 2-inch holes. The machine is built by the Newark Gear Cutting Company, Newark, N. J.

A Reversed Cylinder Press

In this machine the hydraulic cylinder is at the top, together with the electric motor, and acts downward on the work. This is particularly handy in pressing in bushings for rod bearings and similar work. The motor operates the pumps through the eccentrics and long eccentric rods shown. The ram is returned by the counterweight at the left.

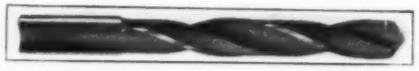
A crane is provided for handling the work and the extension bed or shelves, which are detachable, are very convenient for supporting work, being made especially strong for this purpose. The pedestal legs act as reservoirs for the pumps. It can be supplied to be driven by hand or belt power if desired and is made by the Watson-Stillman Company, New York.



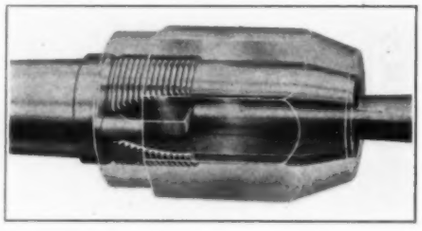
REVERSE CYLINDER PRESS

The Norka Drill and Chuck

This drill is made by twisting a bar of special section, leaving a portion straight for the shank. This is ground to insure centering in the chuck, and the outside of the drill is also ground so as to drill a hole round and true to size. The jaws fit into the straight grooves left for the shank and unquestionably hold with a grip that can only be disturbed by breaking the drill or the chuck. The chuck has two heavy jaws, held by a substantial nut, which insures a drive that will stand up to any work it may be called on to do. The good points of such a combination are too obvious to need further comment. They are both made by the Whitman & Barnes Manufacturing Company, Chicago, Ill.



THE NORKA DRILL

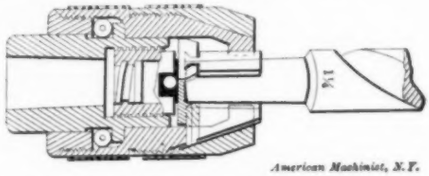


THE NORKA DRILL CHUCK

Improvement in the Morrow Chuck

While the general principles of this chuck remain the same as before, there is an additional refinement in the way of a differential screw by means of which the drill may be loosened by a simple hand movement without the use of a spanner. The way in which this is accomplished can be readily seen from the illustration. The first movement of loosening allows the pressure to be released by the differential screws and the rest is easy.

In spite of this the chuck has a very powerful grip, the chuck shown being only 3 inches in diameter by 4 inches long, and yet holds anything from ⅛ inch up to 1¼ inches and will release by the hand of the operator. These chucks are also made with jaws fitted to grip the standard taper shanks so as to allow drills with broken tangs to be used up.



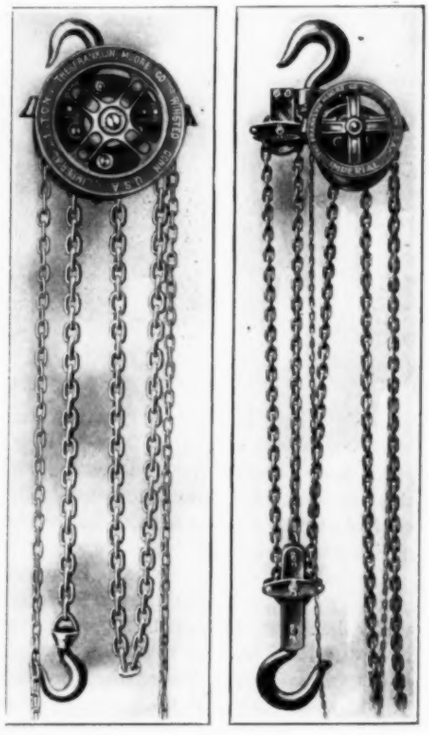
IMPROVEMENT IN THE MORROW CHUCK

These chucks are made by the Morrow Manufacturing Company, Elmira, N. Y.

A Hoist with Several New Features

One of the interesting features of this hoist is the plan of swinging the load direct from the top hook, which allows free action to all the working parts and reduces friction so that the makers claim an efficiency of over 90 per cent. on these machines. The 1-ton block weighs 73 pounds, and with a pull of 81 pounds on the hand chain will raise the load 1 foot for every 25¼ feet of hand-chain travel.

The gears are all cut from high-carbon drop forgings, the housings do not carry any of the load so that danger due to imperfect castings is entirely avoided. Heavy steel yokes connect the load sprocket to the top hook, and are fitted with case-hardened steel rollers, in cages, for the load-shaft bearings. These hoists are very compact, require little head room,

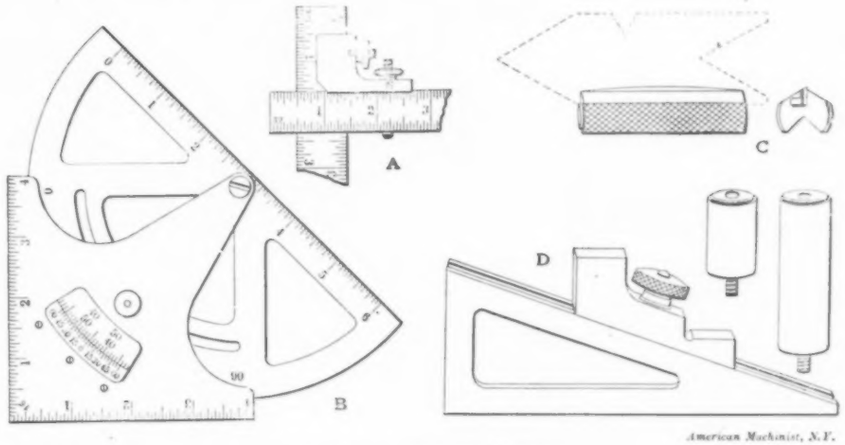


TWO NEW HOISTS

have a two-part, oil-tight housing, and are made in sizes from ½ to 20 tons, by the Franklin Moore Company, Winsted, Conn.

Four New Machinists' Tools

The four tools or attachments shown have recently been added to the line of L. S. Starrett Company, Athol, Mass. At



FOUR NEW MACHINISTS' TOOLS

A is a clamp for holding together the scales from combination squares or plain scales, and needs little description. They are held at right angles, and it is easy to imagine many places where this would be very handy.

At *B* is a protractor of sheet steel, graduated to degrees and figured to read either right or left. It has a vernier that will read to five minutes. The size is shown by the graduations on the square and the blade. It lies flat on the paper and the blade can be locked in any position.

The holder in *C* is for holding the center gage against a lathe spindle or faceplate to aid in setting the thread tool. The block has a V cut out of the bottom to insure parallel setting and holds the gage by the pressure of the flat spring in the slot.

The tool at *D* is a gage for a planer or shaper, to take the distances or hights that might be difficult to get at in the ordinary way. After setting the tool to the piece to be measured, it is taken out and the distance between the proper surfaces measured with a micrometer. The distance blocks shown can be screwed to the upper anvil to increase its capacity.

Double Acting Pipe Wrench

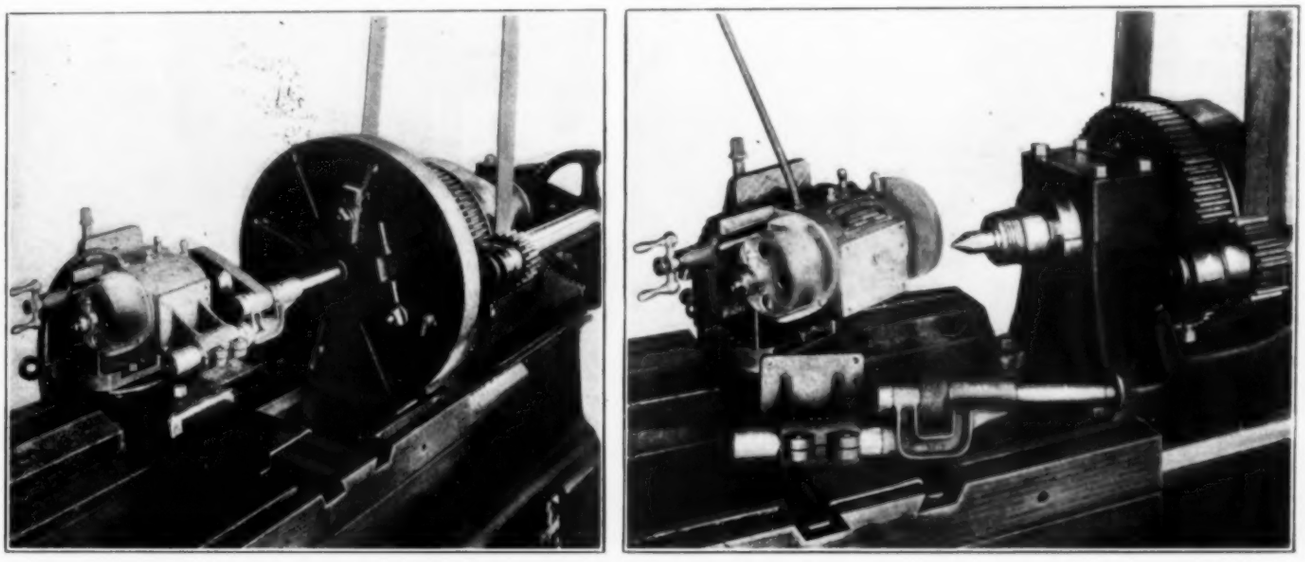
This is something of a novelty in the way of a pipe wrench, owing to its ability to grip in either direction, and in addition, acts as a ratchet both ways. There is very little lost motion, taking up slack at once. Having no teeth it does not mar a finished pipe, and yet it is claimed that it will grip a polished pipe covered with oil, as firmly as necessary. This is possible on account of its frictional grip all around the pipe, both by the chain and the head of the wrench. It releases instantly and requires but six inches of working space to grip and turn a pipe into place. It is known as the Duquette two-way wrench, and is made by the Toledo Wrench Company, Toledo, Ohio.

DOUBLE-ACTING PIPE WRENCH

Electrically Driven Grinding Attachments

The two illustrations show an electric tool-post grinder for both internal and external work. The whole attachment is mounted on the tool slide, having independent adjustment both vertically and horizontally. The internal fixture is separate, and is fastened to the main or motor casting by the four screws shown. It is driven by a small belt from a pulley which is put on the armature shaft in place of the grinding wheel. This spindle has adjustable cone bearings which are dustproof, and runs at 18,000 revolutions per minute, using a 1¼-inch wheel with ¼-inch face. Different length spindles can be had to grind from 4½ to 18 inches in depth. For grinding out dies and similar work in the small-tool room this feature will be found very convenient.

For external grinding, whether truing up centers, as shown, or for grinding reamers, cutters, mandrels, etc., it is very useful, and the motor allows it to be used on a shaper or planer as well as on the lathe. This also has dustproof, adjustable cone bearings, and is made in four sizes, which carry wheels from 4½ to 12 inches in diameter. The motors are supplied for

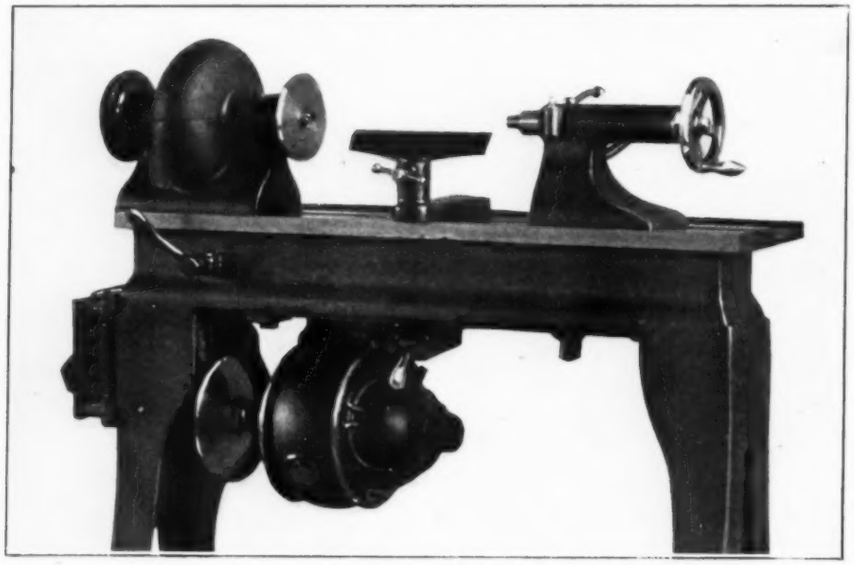


USING AN ELECTRIC GRINDER FOR INTERNAL AND EXTERNAL WORK

almost any current that may be available. It is made by the United States Electrical Tool Company, Cincinnati, O.

Motor Driven Speed Lathe

The success attained by the friction-driven sensitive drill presses manufactured by the Washburn shops of the Worcester Polytechnic Institute, has led to the adaptation of the same principle to a speed lathe intended for service on both wood and metals.



MOTOR-DRIVEN SPEED LATHE

The illustration shows the motor-driven type. The motor is hung from the lathe bed at such an angle that it does not project in front of the bed and is never in the way of the operator. The power is transmitted from the motor to the main spindle by means of a double roll and disk friction.

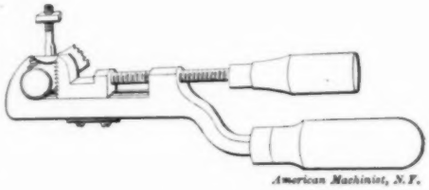
The pressure of the disks on the rolls is controlled automatically by means of a cam clutch, which acts as a positive drive or tightener and increases or decreases the pull of the disk on the roll directly as the work requires, the pressure between the disks and rolls being very slight except when turning.

The variation of spindle speeds is obtained by throwing the lever near the headstock. This slides the rolls across the disk and gives easily a range of speeds of over 4 to 1. The motor is run at 1800 revolutions per minute, and gives a speed variation of the spindle from 600 to 2650 revolutions per minute. The spindle is stopped, without stopping the motor, by throwing the speed lever to its extreme position. When in this position the driver disk is out of contact with the rolls, the disk being recessed for this purpose. This also permits the motor starting without load. The disk on the spindle is wholly inclosed by the headstock and a movable cap, and a hand wheel is provided on the end of the spindle for use as a brake and for placing the work.

The lathe is fitted with either a direct-current or induction motor and a special single-phase motor may be used whereby the lathe can be run from the ordinary lighting circuits, making it of special value for house or garage use. It may also be fitted to run at slower speeds for metal work, and in this case is provided with draw-in chucks and a slide rest.

A New Wrench

As will be seen, this is quite different from the usual form of wrench, having a separate handle for the screw which operates the sliding jaw. It can be used

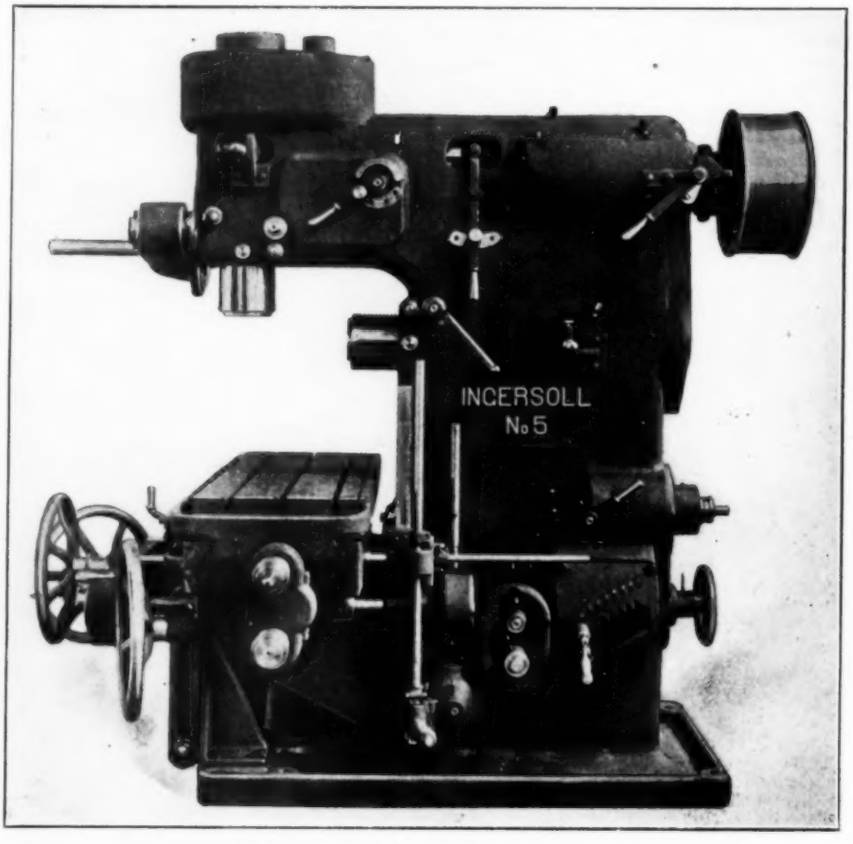


A NEW WRENCH

to hold round-headed bolts, as a pipe wrench, or will cut wire between the jaw points which are in the shape of a bird's beak. The jaw pressure can be judged from the cutting of an ⅛-inch iron wire between the jaws. It is made by the New Metal Tool Steel Company, 338 Cumberland avenue, Portland, Maine.

Improvements in the Ingersoll Milling Machine

The combined vertical and horizontal spindle milling machine brought out about a year ago by the Ingersoll Milling Machine Company, Rockford, Ill., and illustrated on page 918, Part 1, Vol. 31, has been improved in several particulars,



IMPROVED INGERSOLL MILLING MACHINE

as can be seen by comparing the illustrations of the first and the latest machines.

Among the most noticeable of these changes are the three large hand wheels in front to give ready access to the various movements and an easy handling of the machine. The design of the speed and feed boxes has been altered, the supporting arm has been improved, and several minor changes, all tending to improve the usefulness of the machine, will be noticeable to the careful observer.

Chuck for Holding Ring Wheels

This has been designed for use on disk-grinding machines, but is equally applicable to any machine where it is desired to use the ring type of abrasive wheel. As ing ring may be set out as it wears, and still have its full support or backing at all times. This allows the wheel to be used until it is quite thin and gives it a long life.

Perhaps the main advantage of this design and the use of the pressed-steel body is the cutting down of the distance between the outside of the wheel and the outside of the body, this being less than an inch on a holder for an 18-inch wheel. But this construction has further good points, including the strength of the steel shell and the reduction of danger from bursting, as well as the lower weight of metal to be handled. Hubs are made either like Fig. 1 or Fig. 2, according to the machine on which they are to be used. It is made by the Graham Manufacturing Company, Providence, R. I.

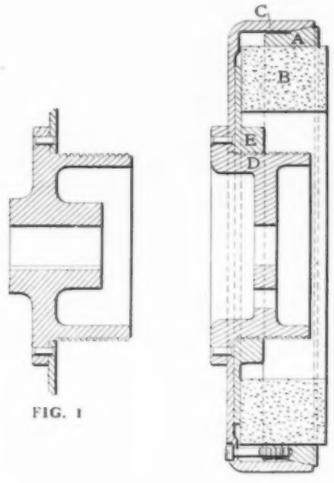


FIG. 1

FIG. 2

American Machinist, N.Y.

THE GRAHAM RING-GRINDER CHUCK

can be seen from Figs. 1 to 3, the chuck consists of a pressed-steel body *C*, mounted on the hub *D* and riveted to it. Inside the body is the split holding ring *A*, turned to fit the taper of the body and drawn in by the fillister-head screws at the back.

The outside of the hub *D* has a square thread on which the backing or regulating flange *E* is screwed, so that the grind-

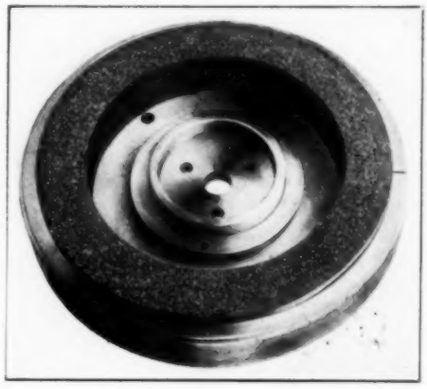


FIG. 3. THE COMPLETE CHUCK

FIG. 1. MULTIPLE DRILL WITH AUTOMATIC FEED

A New Automatic Feed

This machine is the same as the other types manufactured by the Taylor & Fenn Company, Hartford, Conn., with the addition of an automatic power feed that is of new design. Each spindle is independent although this feed may be applied to one so as to feed all simultaneously. Or the power feed can be thrown out at any time. Power for the feed comes from the drill spindle, down through the vertical shaft at the back, driving the worm which turns the worm wheel which has a bronze rim and a hardened-steel center. In this center are the notches for the feeding latch or driving lever. This lever is fastened to a clamp collar that fits on the end of the feed pinion shaft which is an octagon, so as to allow eight settings of the feed lever. The range of feed can be quickly changed, slipping the clamp collar off and re-setting in another position.

The hardened knock off shown in front of the worm wheel in Fig. 2, has an adjustment greater than the distance between the notches in the ring and in this way it can be set to drill any depth of hole with great accuracy. The driving lever is forced out of the notches by the knock out at any pre-determined point.

The range of this machine is from 3/16 to 3/4-inch drills with a maximum feed depth of 3 inches. Two rates of feed are available, one of 0.0074, the other of 0.0096 inch per revolution of spindle. Either feed may be had by loosening a nut on the intermediate gear stud and reversing the gears. All gears are well guarded which not only avoids accidents but also adds to the appearance of the machine.

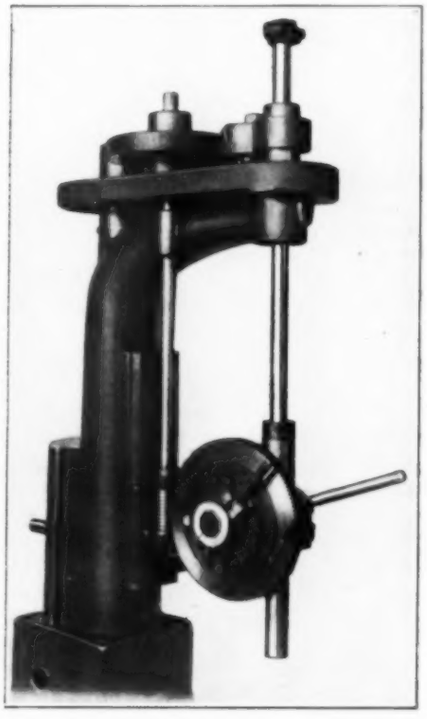


FIG. 2. THE AUTOMATIC FEED

A Test of Novo and Novo-Superior Steels

By M. I. Francis

It was my privilege recently to make some interesting tests as to the staying quality of both Novo and Novo-superior steel, which were carried on with the assistance of Mr. Winder, the inventor of Novo-superior; Mr. Conklin, of the O. K. Tool Holder Company; Herman Booker, E. P. Bullard and several other well known mechanical men.

The tests were carried out on a 24-inch vertical turret lathe and the tools were held in O. K. tool holders. The Novo steel was used in the turret for a cross-cut, in cast iron, that was 1/16 inch thick. The Novo-superior was held in the side head, feeding down on a cut 1/16 inch deep. Both tools were given a feed of 0.048 inch, or nearly 1/20 inch, and were run at a speed of 125 to 130 feet per minute, both tools working on the same piece at the same time.

Fourteen castings were used and were changed as rapidly as possible to avoid any opportunity for the tools to cool. You can readily see by the depths of the cuts that the tests were very severe on the tools, as 1/16 inch does not get very much more than through the scale.

We turned the fourteen pieces in the actual cutting time of 32¼ minutes. In these, 4002½ feet of cast iron passed the point of the tool in 32¼ minutes, with no damage done to either tool. The next casting contained some extra hard spots and on that one the Novo-superior tool burned.

On account of the Novo tool being used on the cross feed the average speed was 110 feet per minute and the cut was shorter, so that 3210 feet of cast iron passed the point of the tool in 32¼ minutes. It was a larger tool and allowed the heat to pass off better and had one-fifth more time to cool between cuts, and while this tool did not burn, it would not have stood more than one more casting.

Next, a ⅝x1-inch solid-forged Novo-superior tool was put in and it fell down in about one-third the time the O. K. tool did, which proves that the 75 tons pressure given the small forging helps and that the heat is carried away in a tool holder as efficiently as with a large forging. As no particular effort was made to remove a large quantity of stock, but just get under the scale, I consider this a remarkable record and think that Mr. Winder has given the mechanical world a wonderful piece of steel.

A Roller Thrust Bearing—Erratum

At page 675, of last week's issue, the address of the Reeves Pulley Company, developers of a new roller-thrust bearing, was given as Columbus, O., but should have been Columbus, Ind.

A Remarkable 5500 Horsepower Pelton Wheel

By Frank C. Perkins

The accompanying illustration, Fig. 1, shows the construction of a new high power Pelton water wheel operating with a head of 730 meters 2200 feet. This turbine was constructed at Geneva, Switzerland, for the Société Des Usines Electriques De La Lonza, to drive electrical generators. It is governed by a regulator shown in the illustration, Fig. 2, operated from the main shaft by a belt connection. This regulator controls the stream impinging on the buckets so that the speed is held constant at 500 revolutions per min-

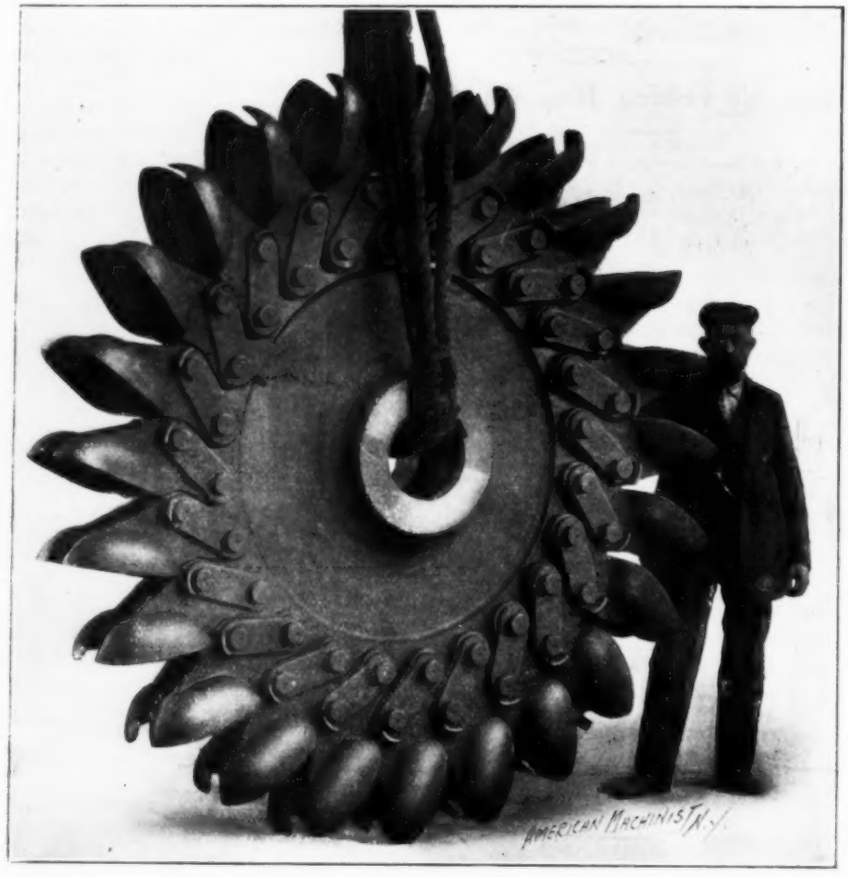


FIG. 1. A LARGE, SWISS, PELTON WATER WHEEL

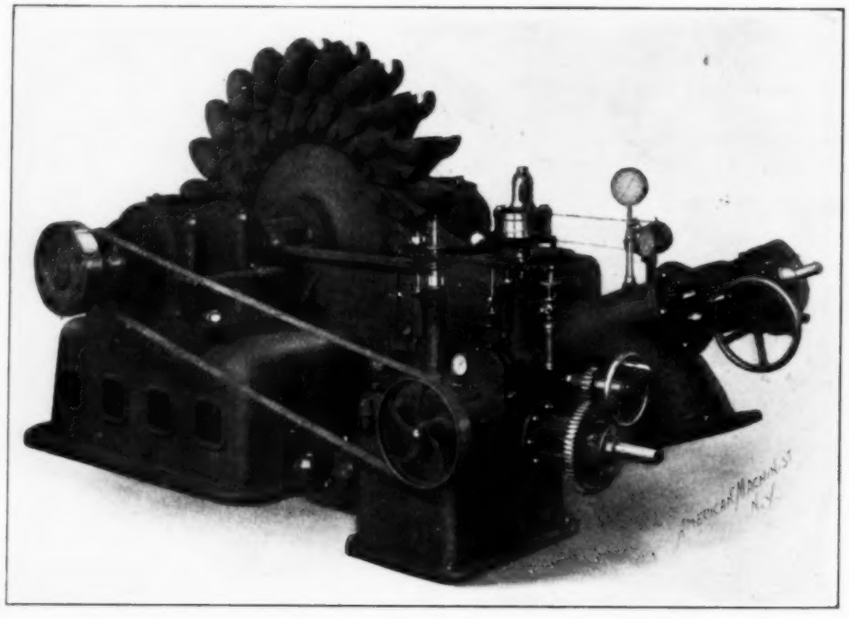


FIG. 2. GOVERNOR OF THE LARGE, SWISS, PELTON WHEEL

ute even under considerable variations of load. This wheel develops 5500 horsepower and is in service at the hydroelectric plant De La Viege De Saas at Valais in Switzerland. The special construction of the buckets and disk is of interest as well as the cutting away of a portion of the buckets for satisfactory operation. This bucket construction was designed by the engineer of the Société Anonyme Des Ateliers Piccard, Pictet & Cie.

An Out-of-the-way Drawing Table

It often happens that the shop manager, superintendent, or general foreman, or perhaps the proprietor of the shop, has ideas of his own which he desires to put on paper before turning them over to the draftsman to be worked out in detail. Few offices have any good place for a regular drawing table and the drawing board which lies on the desk and has to be laid aside at all too frequent intervals is far from being satisfactory in any way.

The photographs show the way in which this problem has been solved by Mr. Cummings, of the Cummings Machine Company, 238 William street, New York City. This consists practically of a shallow cupboard built against the partition of the office and having its front in the form of a very substantial drawing board, as can be seen in both views.

When open for business the short leg on the outside of the board rests on the top of the table underneath, being prevented from marring this by the use of felt on the end of each leg. In this position it represents a good-sized drawing board at the right angle, and, as will be seen, is equipped with a universal drawing machine which always remains in place the same as on any drawing board. The shelves afford convenient places for drawing tools and reference books, while scales, triangles, or anything else which may be used, go at the right.

When from interruption or otherwise it becomes necessary to leave the drawing board, it takes but a moment to close the front, which fastens with a snap lock, and everything is out of the way. At the same time it is thoroughly protected from dirt and inquisitive inspection, as can be seen in Fig. 2, and leaves the table beneath clear for looking over any blueprint or other plan which may be necessary. A drawing-board set of this kind can be used to advantage in many places, especially as the cost is not excessive in any way.

Setting a Gear Hobbing Machine

While gear-hobbing machines are not new, they are not so common as to be gen-

SETTING A SCHUCHARDT & SCHUTTE GEAR-HOBBING MACHINE

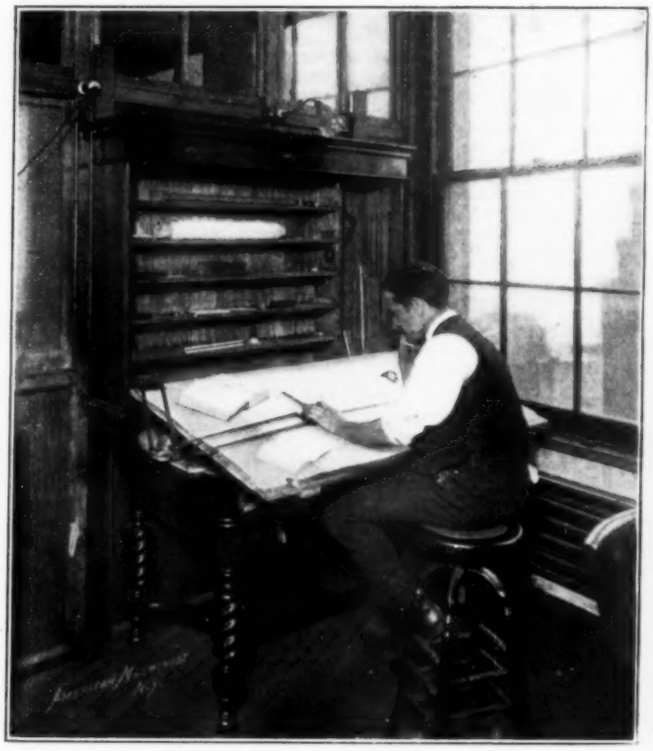


FIG. 1. IN USE

FIG. 2. THE DRAWING BOARD OUT OF USE

erally familiar and we believe many will be interested in the general principles involved. The cutters are marked at the end for the pitch and the angle at which they should be set to cut a spur gear with teeth straight across the face, so the first thing is to swing the cutter head to the required angle as shown.

If a spiral gear is to be cut the head must be set to the angle of the spiral in addition to the angle marked on the cutter. This, however, and the change gearing as well must be worked out in accordance with the directions furnished with each machine.

For spur gears, however, the only thing that remains is to set the hob so that one tooth is central with the center line of the stud carrying the work. This is necessary because the cutter or hob is geared to the table so that both turn together and if the cutter is not set central you cannot cut a perfect tooth.

Taking the case of the Schuchardt & Schütte gear hobber shown, and we turn the table until the mark on the side coincides with the line on the index or pointer. Then the arbor shown is put in place, the cutter moved down until the cutting edge is in line with the pointer on the setting arm which goes over the arbor.

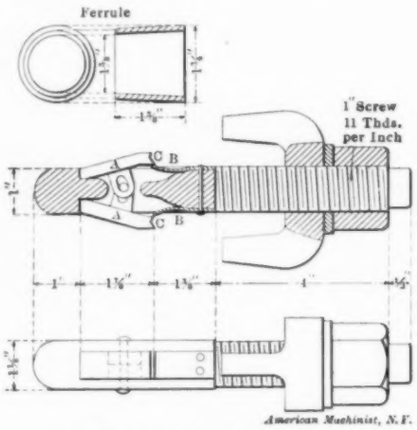
The short pointer or feeler is set against one side of the tooth and the finger at the other end adjusted until it is on the line shown on the setting block which fits into the slot of the table, at right angles to the index mark. Then the setting arm is reversed and the feeler placed against the other side of the same tooth. If the pointer does not come to the mark on the setting block, the tooth is not central and the whole cutter slide is moved across the head until the tooth of the hob stands central with the arbor as will be shown by the setting arm pointer, coming to the line on the setting block, when tried in both positions. After this is accomplished there is nothing more to be done except put on the blank, set the feed in motion and the machine does the rest.

Extracting Boiler Tube Ferrules

By J. H. Edington

The ferrule extractor has been designed to avoid the unnecessary labor that arises when extracting ferrules from the tubes of locomotive boilers. Previously a long bar was put down the tube from the smoke-box end, until the end was against the ferrule; it was then wedged tight against the inside of the tube, and driven through with a hammer. Great inconvenience was caused, especially when the tubes were full of soot. This difficulty, and the time taken to ram a bar through the tubes was considerable, and extremely hard work for the operators.

The extractor is made to push through the ferrule, the jaws *A* contracting to the size of the hole in the ferrule, when being pushed through. When it is through the ferrule, the jaws are pressed hard against the inside of the tube by the springs *B*. It is drawn against the end of the ferrule, and the bevels on the end of the jaws *C* give the jaws a secure catch, being drawn into position. The gland and nut are then put on, the nut being screwed with an ordinary screw key, thus extracting the ferrule.



A HANDY FERRULE EXTRACTOR

I have designed and tested this tool, which gives every satisfaction, and when made of tool steel it is absolutely reliable.

Forthcoming Meetings

American Society of Mechanical Engineers, semi-annual meeting, Washington, D. C., May 4-7. Calvin W. Rice, secretary, 29 West Thirty-ninth street, New York City.

American Supply and Machinery Manufacturers Association, joint convention with Southern Supply and Machinery Manufacturers Association, Chattanooga, Tenn., May 5, 6, 7; headquarters, Hotel Patten.

New York and New Jersey branch, National Metal Trades Association, monthly meeting, May 11, 30 Church street, New York City.

National Supply and Machinery Dealers Association and American Supply and Machinery Manufacturers Association, joint convention, Pittsburg, Penn., May 12-13-14, headquarters Fort Pitt hotel. A. T. Anderson, secretary, Wade building, Cleveland, Ohio.

The Foundry and Manufacturers' Supply Association, convention, Cincinnati, Ohio, week of May 17.

National Association of Manufacturers, fourteenth annual meeting, Waldorf Astoria hotel, New York City, May 17; George S. Boudinot, secretary, 170 Broadway, New York City.

American Foundrymen's Association convention, Cincinnati, Ohio, May 18-20, headquarters Hotel Sinton. Richard Moldenke, secretary, Watchung, N. J.

National Machine Tool Builders' Association, spring meeting, May 25-26, Milwaukee, Wis., headquarters, Plankington house. P. E. Montanus, secretary, Springfield, Ohio.

American Hardware Manufacturers Association, joint convention with Northern Hardware Jobbers Association, Pittsburg, Penn., June 9-11, headquarters Hotel Schenley. F. D. Mitchell, secretary, 309 Broadway, New York City.

Railway Master Mechanics Association, annual convention, June 16-18, Atlantic City, N. J. Jos. W. Taylor, secretary, Old Colony building, Chicago, Ill.

Master Car Builders Association, annual convention, June 21-23, Atlantic City, N. J. Jos. W. Taylor, secretary, Old Colony building, Chicago, Ill.

American Society of Testing Materials, annual meeting, June 29, Atlantic City, N. J. Edgar Marburg, secretary, University of Pennsylvania, Philadelphia, Penn.

Business Items

Dodge & Day, engineers, Philadelphia, have recently installed gas producers and regenerative gas furnaces of their own design in the plants of the Bradlee Chain Works and the Fayette R. Plumb Companies, in Philadelphia. In both of these installations the boilers, as well as the furnaces, are fired by gas from the producer.

Business Opportunities

Temple Iron Works, Temple, Texas, will rebuild burned plant.

C. F. and A. N. James, Mt. Pleasant, N. C., will establish knitting mill.

Holden & Tucker, Chrisman, Ill., are building a machine shop and garage.

The E. & G. Brooke Iron Co., Birdsboro, Penn., is to build a new blast furnace.

The Wichita (Kans.) Canning Company has bought site for a new canning factory.

The Chamberlain Machine Works, Waterloo, Iowa, will erect an addition to plant.

The Berger Manufacturing Company, Canton, Ohio, will erect a new galvanizing plant.

A new boiler shop is to be built for the Reading (Penn.) Iron Company at a cost of $10,000.

The plant of the Faribault (Minn.) Gas Engine Company, recently burned, will be rebuilt.

The Screw Machine Products Corporation, Providence, R. I., is to erect a new plant.

Plans are being prepared for a new factory for the Weinman Machine Works, Columbus, Ohio.

The Ohio Steel Wheelbarrow Company, Toledo, Ohio, is contemplating establishing a plant in the South.

The Ballard Knitting Company, Norristown, Penn., is to erect a new plant at a cost of about $100,000.

The American Optical Company, Southbridge, Mass., will erect a new building at a cost of $200,000.

Fire destroyed the plant of the Ahlbrand Carriage Company, Seymour, Ind., causing a loss of $50,000.

The Plant of the Greensburg Foundry and Machine Company, Jeannette, Penn., was destroyed by fire. Loss $30,000.

The Buckeye Aluminum Company, of Doylestown, Ohio, will move to Moundsville, W. Va., where a new plant will be erected.

The Goldsboro (N. C.) Traction Company will erect repair shop in East Goldboro. E. T. Oliver, Raleigh, is president.

The Providence (R. I.) Gas Company has awarded contract for the erection of a $1,000,000 coal-gas plant at Sassafras Point.

The Sterling Engine Company, Buffalo, N. Y., will erect an addition to be used as a foundry and additional machine shop room.

It is reported that the Maryland Steel Company, Sparrows Point, Md., will build an open-hearth steel plant to cost $1,000,000.

The Merwin Manufacturing Company, Cleveland, Ohio, manufacturing sheet-metal specialties, will erect a two-story addition.

The Boston & Maine Railroad is shortly to start construction of repair plant at East Somerville, which is to cost nearly $2,000,000.

The L. C. Smith & Bro. Typewriter Co., Syracuse, N. Y., is having plans prepared for an addition to plant, which is to cost about $200,000.

The American Radiator Company, of New York and elsewhere, is now to enter the southern field and will establish a plant at Birmingham, Ala.

Plans are being prepared by Dodge & Day, Philadelphia, Penn., for a new plant for the Emerson Steam Pump Company, Alexandria, Va.

A new building is being erected for John Henderson & Sons, Jersey City, N. J., who will conduct a foundry, blacksmithing and machine manufacturing business.

It is reported that the Hicks Car Company, of Chicago, is to erect a plant at New Brighton, Minn., near the proposed car and repair shops of the Armour Packing Company.

The new Burrell-Johnson Iron Company, Yarmouth, N. S., will rebuild plant recently burned. The new plant will be equipped with a ten-ton crane and modern machine tools. F. A. Waldron, 37 Wall street, New York, is architect and engineer.

Sealed proposals will be received by Lieut.-Col F. E. Hobbs, Rock Island Arsenal, Rock Island, Ill., up to 2 p.m., May 24, for furnishing hardware, leather, steel, iron, cleaning materials, oils, paints, chemicals, etc., for the fiscal year ending June 30, 1910.

The Isthmian Canal Commission, Washington, D. C., will receive up to 10:30 a.m., May 10, proposals to furnish during the fiscal year ending June 30, 1910, the following: Manganese steel castings, valves, hose couplings, cocks, pipe fittings, etc., as per Circular No. 504.

The Navy Department, Bureau of Supplies and Accounts, will open the following bids: May 4—Steel castings (schedule 1178), brass screws (schedule 1179); May 11—Forced draft system (schedule 1182), engine lathes (schedule 1185), lubricating oil (schedule 1184).

The Watervliet Arsenal, Watervliet, N. Y., will receive sealed proposals in triplicate until 1 p.m., May 17, 1909, for furnishing iron, steel, hardware, fuel, oil, etc., during year ending June 30, 1910. Information furnished on application to Lieut. Col. W. W. Gibson, commanding.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., May 6, for semi-marine boilers, air compressor, electric motor, electric-driven woodworking machines, turret lathe, bolt cutter, shears, punch, friction drill, drill chucks, drill-press vise, shafting, etc., as per Circular No. 503.

New Incorporations

The Rome (Ga.) Scale Company has been organized with $12,500 capital to manufacture scales. Site for building has been purchased.

The Oliver Whyte Company, Boston, Mass., has been incorporated to manufacture and sell metal work of all kinds. Capital, $15,000. Oliver Whyte, Medford, Mass., president.

Elliott Galvanizing Company, Jersey City, N. J., has been incorporated with $125,000 capital to galvanize iron and other metals. Incorporators, W. W. Elliott, J. N. Elliott, F. J. Higgins.

The Peerless Ventilator Company, Buffalo, N. Y., has been incorporated with $200,000 capital to manufacture ventilating devices. Incorporators, H. A. Holden, J. G. Herb, W. H. Barnhart.

The Marshall Machine and Pattern Company, Boston, Mass., has been incorporated with $50,000 capital. J. J. Wylde, Woonsocket, R. I., treasurer. Will manufacture and sell machinery.

Manganese Steel Safe and Vault Company, Plainfield, N. J., incorporated to manufacture safes, vaults, etc. Capital, $100,000. Incorporators, Robert E. Jennings E. Knox Taylor, Frank H. Bucklin.

The Shelton Electric Company, 103 Randolph street, Chicago, Ill., has been incorporated to manufacture electrical apparatus. Capital, $100,000. Incorporators, G. Shelton, A. J. Crowley, C. H. Haft.

The Scovil Iron and Steel Company, Jersey City, N. J., has been incorporated to manufacture iron and steel products. Capital, $25,000. Incorporators, Percy A. Scovil, E. M. Scovil, William J. Crompton.

The Automatic Press Feeder Company, Chicago, Ill., has been incorporated. Capital, $100,000. Incorporators, L. Markley, C. A. Williams, L. R. Sterre. Will manufacture machinery, tools, etc.

The St. Mary's Manufacturing Company, St. Marys, Ohio, has been incorporated with $75,000 capital to manufacture washing machines, etc. Incorporators, W. A. Mackenbach, H. F. Schroeder, G. F. Boos, etc.

The Universal Recorder Manufacturing Company, Chicago, Ill., has been incorporated to manufacture time recorders. Capital, $250,000. Incorporators, Bruce G. Powell, Almon W. Bulkley, C. Paul Tallmadge.

Elizabeth Sash, Door and Supply Company, Elizabeth, N. J., has been incorporated to manufacture sash, doors, blinds, etc. Capital, $100,000. Incorporators, J. G. Hartfelder, George Schleuning, William Heilich.

The Magnetic Locomotive Company, Marquette building, Chicago, Ill., has been incorporated to manufacture electrical devices and machinery. Capital, $100,000. Incorporators, Frank B. Tinker, W. S. Perry, J. R. Markle.

The Air Turbine Company of America, Jersey City, N. J., has been incorporated to manufacture air mills, wind mills, etc. Capital, $1,000,000. Incorporators, E. McVickar and R. H. Eggleston, of New York; A. M. Higgins, Montclair, N. J.

The Bryant Chucking Grinder Company, Springfield, Vt., has been organized with James Hartness, of the Jones & Lamson Machine Co., as president, and W. L. Bryant, treasurer and and manager. The company will manufacture a chucking grinder invented by Mr. Bryant. A new shop will be erected at once.

New Catalogs

The Avery Stamping Company, Cleveland, Ohio. Circular illustrating and describing metal stampings.

Bath Grinder Company, Fitchburg, Mass. Catalog describing grinding machines. Illustrated. 56 pages, 7x9½ inches, paper.

Mound Tool and Scraper Company, St. Louis, Mo. Catalog of tools for the automobile. Illustrated, 12 pages, 3½x6 inches, paper.

Roth Bros. & Co., 136 Liberty street, New York. Bulletins No. 182 and 193, describing dynamos and motors. Illustrated, 6x9 inches.

Niles-Bement-Pond Company, 111 Broadway, New York. Catalog of heavy milling machines. Illustrated, 54 pages, 9x12 inches, paper.

American Blower Company, Detroit, Mich. Catalog No. 251, describing Sirocco blowers and fans, etc. Illustrated, 24 pages, 7x9 inches, paper.

Franklin Machine Company, Franklin, Penn. Circular illustrating and describing Coffman No. 2 universal boring, drilling and Milling machine.

The Carborundum Company, Niagara Falls, N. Y. Booklet, "Revised American Statesmen Series," Vol. 1, being a satire on Christopher Columbus.

Hill Clutch Company, Cleveland, Ohio. Pamphlet, entitled "Tests of Friction Clutches for Power Transmission," by Prof. R. G. Dukes. Illustrated.

American Compressor and Pump Company, 26 Cortlandt street, New York. Bulletin A, describing Peerless air compressors. Illustrated, 16 pages, 6x9 inches.

Goldschmidt Thermit Company, 90 West street, New York. Pamphlet, describing Thermit welding of castings and forgings. Illustrated, 20 pages, 6x9 inches.

Cleveland Automatic Machine Company, Cleveland, Ohio. Catalog of automatic screw machines, attachments and tools. Illustrated, 114 pages, 6x9 inches, paper.

The Phosphor-Bronze Smelting Company, 2200 Washington avenue, Philadelphia, Penn. Price List No. 24 of phosphor bronze and other alloys. 24 pages, 3½x6 inches.

Hammacher, Schlemmer & Co., 4th avenue and 13th street, New York. Circular No. 363, describing work benches for cabinet makers, manual training schools, home use, etc. Illustrated.

General Electric Company, Schenectady, N. Y. Bulletin No. 4653, describing Curtis steam turbine-generator. Illustrated, 54 pages, 8x10½ inches, paper. Pamphlet No. 3768, showing motor starting and speed controlling devices. 34 pages, 3½x6 inches.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith, Columbia, Penn.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

A large foundry and machine shop desires to add to present lines of manufacture. Box 126, AMERICAN MACHINIST.

Machines designed; automatic, special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

A small but well equipped machine shop in Connecticut desires to add other devices to its present line. Box 164, AMERICAN MACHINIST.

Wanted—Work for an up-to-date machine shop. We build all kinds of light machinery, dies, manufacturers' jigs, etc. M. J. Boyce, 584 Hudson St., New York City.

A well equipped office at 50 Church Street, New York, can afford desk room, stenographic and telephone service to machinery house desiring New York office. Box 161, AM. MACH.

Inventions the basis of progress. Have you any? I develop inventions to a practical and commercial basis. Benj. Brownstein, Mechanical Engineer and Expert Designer, Trenton, N. J.

I have an excellent manufacturing proposition awaiting capital. Am ready and willing to demonstrate its merits to the right party. If interested, address "Rare Chance," Box 153, AMERICAN MACHINIST.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Proposals for Ordnance Supplies—Watervliet Arsenal, Watervliet, N. Y., April 17, 1909. Sealed proposals, in triplicate, will be received until 1 p.m., May 17, 1909, for furnishing iron, steel, hardware, forage, fuel, oils,

etc., during year ending June 30, 1910. Information furnished on application. Lt. Col. W. W. Gibson, Comdg.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

DELAWARE

Mechanical draftsman, experienced principally on machine tools, now employed, wishes to change. Box 157, AMERICAN MACHINIST.

ILLINOIS

A designing draftsman with experience on machine tools, special machinery and shop equipment for manufacturing wants a western position. Box 168, AMERICAN MACHINIST.

MASSACHUSETTS

Position as manager or superintendent of machine works by experienced man. Box 173, AMERICAN MACHINIST.

NEW JERSEY

Mechanical draftsman wishes to change. Address Box 152, AMERICAN MACHINIST.

Automobile repair and contract shop machinist, married, 26 years old, several years' foreman, desires position. Box 175, AM. M.

Competent designer (25) with nine years' shop and drawing room experience, wishes position as salesman or demonstrator. Box 169, AMERICAN MACHINIST.

Expert screw machine foreman desires change. First class tool designer and maker for hand and automatic machines. Can furnish best of reference. Box 159, AMERICAN MACHINIST.

NEW YORK

Young man, five years' toolmaking, wants position as improver. Box 172, AM. MACH.

Position as draftsman; four years' drafting, two years' shop work. Now employed. Box 158, AMERICAN MACHINIST.

Mechanical draftsman, technical graduate, seven years' experience mostly in automobile and gas engine, wishes position. Box 165, AMERICAN MACHINIST.

Progressive machine shop and factory superintendent; very successful organizer and cost reducer; wants to change. Location immaterial. Box 154, AMERICAN MACHINIST.

Toolmaker and machinist, German, 35 years of age, 20 years experience on tools, automatic machinery, also die work, wants steady position in or near New York. Box 167, AM. MACH.

Responsible position desired by an all around mechanic; first class designer and draftsman; thoroughly experienced, good executive. Will go anywhere if conditions are satisfactory. Box 162, AMERICAN MACHINIST.

Engineer, 30 years old, technical graduate, desires position as works manager or superintendent. Four years shop and drafting; four years installing cost and shop systems. Box 160, AMERICAN MACHINIST.

$3000 man desires change; five years in responsible position, large concern; successful record as executive, organizer and designer in engineering, manufacturing and inspection department; 15 years' experience light and medium interchangeable work. Box 170, AMERICAN MACHINIST.

OHIO

Reliable references will inform you that I am a very practical, profitable executive in mechanical manufacture. Please get me busy. Box 135, AMERICAN MACHINIST.

Engineer of established reputation, wide experience apprentice to works manager, intimate knowledge of best shop and machine tool practice on heavy work, gilt-edged record, is open for engagement as works manager with full responsibility and can deliver the goods. Box 865, AMERICAN MACHINIST.

FOREIGN

Superintendent wants position in Europe; for the last six years in America. A systematizer, shop organizer and modernizer; thoroughly acquainted with the designing of labor-saving tools and devices; can show results; speaks English, German, French and some Russian. Address "Foreign," AMERICAN MACHINIST, London, England.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Position vacant for good mechanic in sheet metal stamping business in Canada. One that could interest himself financially. Box 155, AMERICAN MACHINIST.

CONNECTICUT

Engineer wanted by a large manufacturing concern building automobile and marine motors. Must have had several years' experience in designing automobile and marine gasolene motors. None but the best need apply. Good permanent position to right man. Give references, experience and salary wanted. "Engineer," Box 124, AMERICAN MACHINIST.

Wanted—By large machinery manufacturing concern, chief inspector. Must be first-class mechanic, experienced on gasolene motor work. Capable of organizing and directing corps of inspectors. Good permanent position to right man. Give references, experience and salary wanted. "Chief Inspector," Box 123, AM. MA.

Wanted—By a large manufacturing company, general superintendent, to take charge of a factory making gasolene automobile motors and other high class machinery products. Must be a good producer and a hustler. None but the best need apply. Good permanent position to the right man. Give references, experience and salary wanted. "General Superintendent," Box 120, AMERICAN MACHINIST.

INDIANA

Wanted—A-1 man for foreman drop forge department of 10 board and steam hammers. State experience, salary expected, reference. Address "Manufacturers," care AMER. MACH.

Wanted—Large automobile manufacturers want general foreman for machine shop employing 500 men. State experience, salary, reference, etc. Address "Automobile," care AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—Practical gear cutting expert on all classes of gear work. State age, experience and wages expected. Boston Gear Works, Norfolk Downs, Mass

Wanted—Experienced operator on bevel gears to run Gleason machines. State age and give references. Boston Gear Works, Norfolk Downs, Mass

Wanted—An assistant to superintendent and general manager in a large gear jobbing shop. Must be experienced in mechanical work, technical and practical; also up-to-date on modern methods. State age, experience and salary expected. Boston Gear Works, Norfolk Downs, Mass

Wanted—A designing engineer familiar with modern high and medium speed steam engine practice; must be able to show a satisfactory experience and refer to a successful practice on not less than three years with a standard concern. A knowledge of economical manufacturing methods for quantity production desired. Box 102, AMERICAN MACHINIST.

Wanted—A general foreman familiar with modern practice in high and medium speed engine construction; must know how to get best efficiency from up-to-date tools and equipment. Only such applicants will be considered as can show an executive experience of not less than three years with an up-to-date manufacturing company. Familiarity with modern factory systems necessary. Box 101, AM. MACH.

MICHIGAN

Wanted—A first class mechanical draftsman, experienced in machine tool design. State age, experience, salary expected and give references. Box 156, AMERICAN MACHINIST.

Wanted—Good operators on National Acme automatic machines. Will pay good wages to first-class men. Also two or three good Potter & Johnson operators. Cadillac Motor Car Co., Detroit.

NEBRASKA

Wanted—Foreman to take charge of a marine gas engine factory. Must have an experienced man capable of handling good men and producing high class work. Box 139, AMER. MACH.

NEW HAMPSHIRE

Wanted—A young man about 25 years of age with technical training and good experience on machine manufacturing, who has had charge of help, to act as assistant in machine shop on small interchangeable work. Good chance for advancement for the right man. Box 163, AMERICAN MACHINIST.

NEW JERSEY

Wanted—Two competent draftsmen for printing press work. State age, experience, references and salary. Box 138, AMER. MACH.

Wanted—First-class head draftsman capable of designing modern printing machinery for an established manufacturing concern near New York. Must have knowledge of economical manufacturing methods. Address, giving full particulars, age and salary, "Opportunity," AMERICAN MACHINIST.

In our rapidly growing business of the manufacture of a well known article, we always have openings for draftsmen and toolmakers on small tools, jigs, sub-press dies and special machinery. We invite applications from first-class men on this kind of work. Box 884 AMERICAN MACHINIST.

Wanted—General foreman not under 30 years, as assistant to superintendent, in a large printing machine factory near New York. Must have good executive ability, thoroughly practical, and up to all modern manufacturing methods. Address, giving full particulars, age and salary, Box 166, AMERICAN MACHINIST.

NEW YORK

Mechanical engineer to act as master mechanic and designer of special machinery in large manufacturing plant. Box 174, AM. M.

Wanted—First-class salesman, must have established trade among steam users in engineers' and factory supplies in Greater New York and vicinity. Fine position for right man. Box 131, AMERICAN MACHINIST.

Wanted—By manufacturer, thoroughly experienced man to sell hangers, shafting and transmission machinery in New York City and vicinity. Must be capable, energetic. We want the best man in this line of business. Box 130, AMERICAN MACHINIST.

Wanted—Shop superintendent, practical, experienced, modern shop methods required, steady position, fast growing business. Address, stating qualifications, experience and wages desired. None but first-class men need reply Kerr Turbine Co., Wellsville, N. Y.

Factory manager, thoroughly qualified to take charge of small plant manufacturing automobile parts and gasolene engines; must be thoroughly experienced, educated and energetic; a party with some means preferred who can take a large interest financially so as to make his connection permanent. We desire a very high grade man in every respect. Jamesville Mfg. Co., Jamesville, N. Y.

Sales manager, mechanically trained, capable of developing the sales end of a small factory manufacturing automobile parts. The right party will be given full charge of the selling end of the business, and we prefer a man of means who can take a financial interest in the concern so as to make his connection permanent. The applicant must show successful experience in similar lines for an extended length of time. Jamesville Mfg. Co., Jamesville, N. Y

OHIO

Wanted—Superintendent in large Ohio sheet-metal-working plant; must have thorough knowledge best shop practice and ability to handle men; state age, experience and salary. Box 171, AMERICAN MACHINIST.

PENNSYLVANIA

Wanted—Two machinists experienced erecting high-speed steam engines in shop and on road. Give details of past experience and wages. Box 42, AMERICAN MACHINIST.

For Sale

Machine shop for sale; in good running order to do either iron or wood work of all kinds. Good reasons for selling. Maria Stein Machine Works, Maria Stein, Ohio.

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Dickinson, Thos. L., New York.
Norton Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.

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Ingersoll-Rand Co., New York.

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Barrels, Steel

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Bars, Boring

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Cleveland Twist Drill Co., Cleveland, O.

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Pickering Governor Co., The, Portland, Conn.

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Belt Shifter

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Link Belt Co., Phila., Pa.

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Chicago Raw Hide Mfg. Co., Chicago, Ill.
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Wallace Supply Co., Chicago, Ill.

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Electric Welding Products Co., Cleveland, Ohio.

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See Hoists, Hand.

Blocks, Die

Nicholson & Co., W. H., Wilkes-Barre, Pa.

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Foote-Burt Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Landis Machine Co., Waynesboro, Pa.
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National Machinery Co., Tiffin, O.
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Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.

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Vandyck Churchill Co., New York.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Lang Co., G. R., Meadville, Pa.

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Electric Welding Products Co., Cleveland, Ohio.
National-Acme Mfg. Co., Cleveland, O

Bone for Case Hardening

Rogers & Hubbard Co., Middletown, Conn.

Books, Technical

American School of Correspondence, Chicago, Ill.
Hill Publishing Co., New York.
International Text Book Co., Scranton, Pa.
Sames, Chas. M., Jersey City, N. J.

Boosters

C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
Fort Wayne Electric Works, Fort Wayne, Ind.
General Electric Co., New York.
Roth Bros. & Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal

Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Betts Mach. Co., Wilmington, Del.
Detrick & Harvey Mach. Co., Wilmington, Del.
Fitchburg Machine Works, Fitchburg, Mass.
Foedick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Inc., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, O.
Manning, Maxwell & Moore, Inc., New York.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
New Haven Mfg. Co., New Haven, Conn.
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Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Universal Boring Mach. Co., Hudson, Mass.
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Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.

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American Tool Works Co., Cin., O.
Baker Bros., Toledo, O.
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Flather Mfg. Co., E. J., Nashua, N. H.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Manning, Maxwell & Moore, Inc., New York.
Marshall & Huschart Machinery Co., Chicago, Ill.
McCabe, J. J., New York.
Mitts & Merrill, Saginaw, Mich.
Newton Machine Tool Wks., Inc., Phila., Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Boring Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Krieger Tool & Mfg. Co., Chicago, Ill.

Brazing

Industrial Oxygen Co., New York.
Sanford Mfg. Co., F. C., Bridgeport, Conn.

Broaching Machines

Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Lapointe Mach. Tool Co., Hudson, Mass.

Buckets, Coal

Link Belt Co., Philadelphia, Pa.

Bulldozers

Bliss Co., E. W., Brooklyn, N. Y.
National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York

Cabinets, Tool

Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Patterson, Gottfried & Hunter, New York.

Calipers

Brown & Sharpe Mfg. Co., Providence, R. I.
Schuchardt & Schutte, New York.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams

Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.
Fuller Manufacturing Co., New Haven, Conn.

Carborundum

See Grinding Wheels.

Carborundum Paper and Cloth

Carborundum Co., Niagara Falls, N. Y.

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Link Belt Co., Philadelphia, Pa.

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American Gas Furnace Co., New York.
Rogers & Hubbard Co., Middletown, Conn.
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Lumen Bearing Co., Buffalo, N. Y.

Castings, Die Molded

Berry & Parker, Erie, Pa.
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Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Buffalo Fdry. & Mach. Co., Buffalo, N. Y.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Link Belt Co., Philadelphia, Pa.
Taylor & Fenn Co., Hartford, Conn.
Veeder Mfg. Co., Hartford, Conn.
Wheeling Mold Fdry. Co., Wheeling, W. Va.

Castings, Steel

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Hess Bright Mfg. Co., Phila., Pa.
United Engineering & Fdry. Co., Pittsburg, Pa.

Cast Iron Brazing

Industrial Oxygen Co., New York.
Sanford Mfg. Co., F. C., Bridgeport, Conn.

Cement, Cast Steel

Obermayer & Co., S., Cincinnati, O.

Cement, Iron

Smooth-On Mfg. Co., Jersey City, N. J.

Centering Machines

Hendey Mach. Co., Torrington, Conn.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.

Centering Machines—*Cont.*

Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer

Cincinnati Planer Co., Cincinnati, O.
Fay & Scott, Dexter, Me.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving

Boston Gear Works, Norfolk Downs, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Conn

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American Tool Wks. Co., Cin., O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Garvin Mach. Co., New York.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
McCabe, J. J., New York.
Reed Co., F. E., Worcester, Mass.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill

Almond Mfg. Co., T. R., Ashburnham, Mass.
Brown & Co., R. H., New Haven, Conn.
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Cleveland Twist Drill Co., Cleveland, O.
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Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe

Cincinnati Chuck Co., Cincinnati, O.
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Russell Anti-friction Drill Chuck Co., Elmira, N. Y.
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Union Mfg. Co., New Britain, Conn.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Magnetic

Walker & Co., O. S., Worcester, Mass.

Chucks, Planer

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Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Conn.

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